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# Difficult Dredging Operations at Bermuda

**Two Powerful Bucket Dredgers with a Specially Constructed Drill Scow Make Rapid Progress in Opening Up the Town Cut Channel at St. Georges**

Next to the tourist business, Bermuda's greatest prospects are undoubtedly in connection with the bunkering of steamships, and in administering "first aid to the injured" to distressed shipping. Owing to the lack of channel accommodation at St. Georges, this business has been almost exclusively carried out at Murray's anchorage, an open roadstead with no accommodation. Realizing that unless steps were taken to provide safe and economical harbor accommodation at St. Georges this most important trade would be deflected to other ports, the Government of Bermuda had the dredger *King George* built specifically to dredge the Town Cut channel at St. Georges.

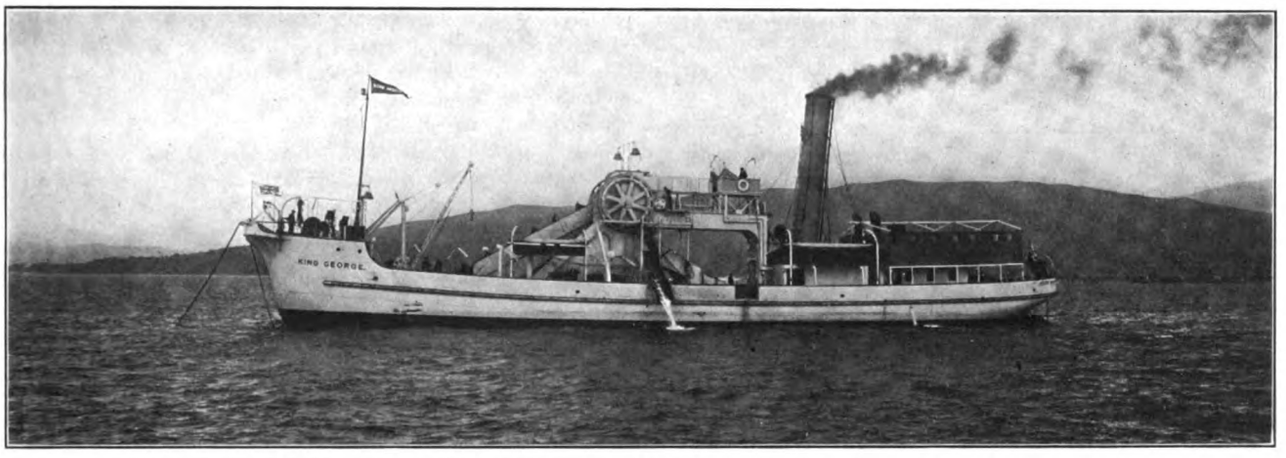


Fig. 1.—Twin-Screw Bucket Dredger *King George* in Operation at Bermuda

The conditions are extremely severe, as the majority of the material to be dredged is a very tough conglomerate, presumably originally the ocean bed, which had been forced by some peculiar convulsion of nature to the surface, and there forming the nucleus for the group of the Bermuda Islands. This rock, in combination with an almost ever-present ocean swell at the outer portion of the channel, has presented conditions bristling with difficulties.

The *King George,* which is a bow well, twin screw, bucket and ladder hopper dredge, built by Messrs. Lobnitz & Company, of Renfrew, has successfully coped with this work. The buckets, 32 in number, are of cast steel body, with manganese steel cutting lips, and travel at the rate of about 16 per minute. A few minutes' experience on the *King George* while at work will convince the most skeptical that any other material of a lesser degree of hardness than manganese steel would be utterly valueless in dredging this Bermuda lime stone. The hoppers, when full, hold 400 tons, and this load is generally augmented by from 15 to 20 tons of boulders, which have to be taken out of the buckets and placed on deck to prevent wrecking the shoots.

Blasting, which has to be resorted to constantly, is carried out from the drill scow *Suffragette.* Previous to the building of this drill scow, the drilling was carried out from the dredger. Two Ingersoll-Rand H.9 drills were mounted, one on each bow, and the dredger was moored for drilling by lowering the ladder to the bottom, acting as spuds. This necessitated the complete discontinuance of dredging operations while drilling; and as about four days' drilling was necessary to prepare for two days' dredging, this gave an output of about 900 tons of hard rock per week. It can readily be seen that the dredger, while economical for its legitimate work, was a most expensive tool when used for a drill scow. The output of rock, since the building of the drill scow, has been raised from 900 to over 4,000 tons per week. It is interesting to note that this material is being dredged for about 50 cents (2/1) per cubic yard.

When open the Town Cut channel will be 120 feet wide at the bottom, and 24 feet deep at low water, giving a perfectly straight channel from the sea to the commodious harbor of St. Georges. By means of range lights placed ashore, it will be comparatively easy for vessels to enter port at any hour at night as well as in daylight, in about 15 minutes from the sea.

Owing to the rapidly increasing tourist trade to Hamilton, it became obvious that these channels would have to be opened

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to meet the demand of the large ships engaged for this trade, before the *King George* could complete the St. Georges channel, and so a second dredger was ordered from the builders of the *King George*. This dredger, the *Queen Mary*, arrived at Bermuda after a particularly hard passage, in January last, and is a duplicate of the *King George*.

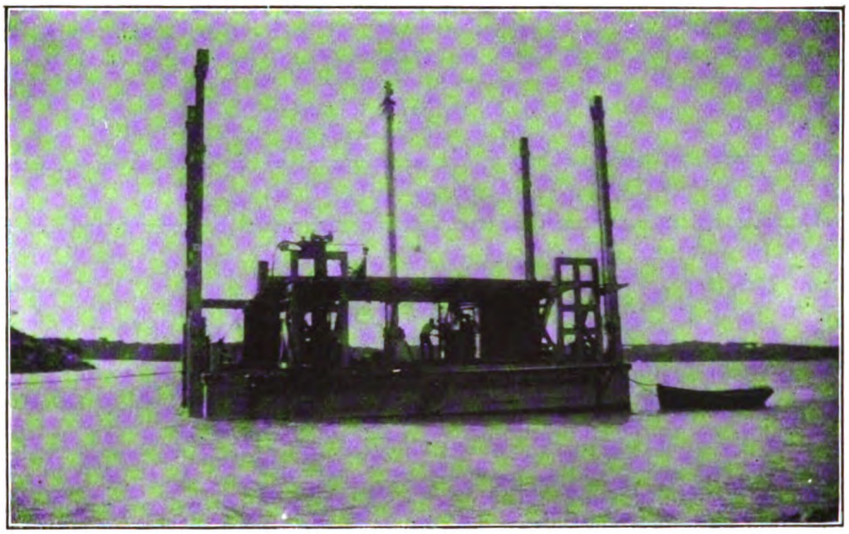

Fig. 2.—Drill Scow *Suffragette*

Both dredges were built by Messrs. Lobnitz & Company, Ltd., Renfrew, to designs of Messrs. Coode, Matthews, Fitzmaurice and Wilson, London. They are 170 feet long, 34 feet beam, and 13 feet 3 inches depth. Propulsion is by twin screws driven by triple-expansion, three-crank engines of a collective indicated horsepower of 1,200. Each of the propelling engines can be coupled to the dredging gear. The dredging buckets are of 9 cubic feet capacity each, and the gearing throughout is of steel, teeth being machine-cut from the solid. The top tumbler wheels are fitted with lubricated side friction of the usual Lobnitz pattern, which can be adjusted to slip at the desired horsepower. The auxiliaries include an electric lighting plant, Weirs pumps, an evaporater, filter, feed-water heater, and steam steering gear, besides the usual deck auxiliaries. Accommodations for the officers are arranged in deckhouses on the upper deck, the woodwork throughout being of teak.

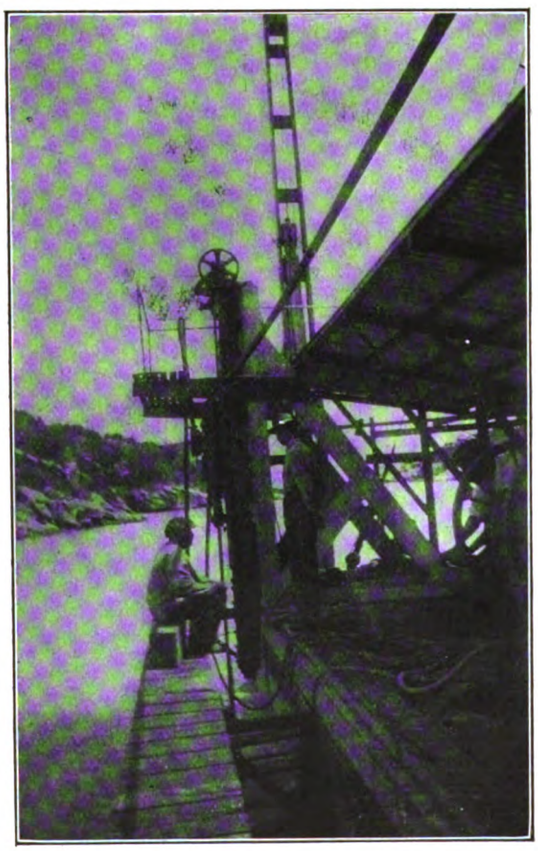

Fig. 3.—Ingersoll-Rand Drill in Operation on the *Suffragette*

The *Queen Mary* is employed improving the Staggs channel, near the government dockyard. The fact that a small colony like Bermuda, with a population of 20,000 people, has purchased and paid for two dredgers, costing about $350,000 (£71,800), and are spending about $80,000 (£16,400) per annum in channel improvement, is good evidence that they not only expect a healthy increase in their tourist business, but that they intend to be prepared for an increased volume of business when the Panama Canal is open.

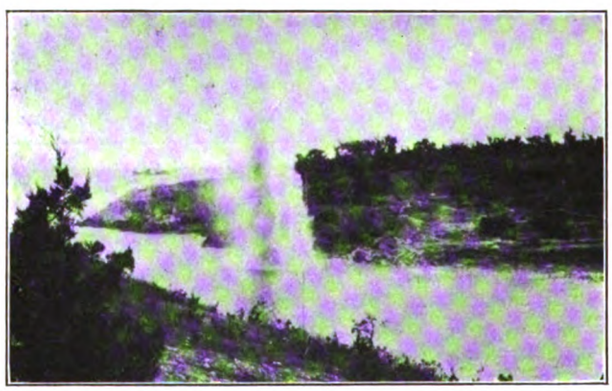

Fig. 4.—Explosion in Town Cut Channel

The drill scow *Suffragette* was designed and built by Mr. W. B. Smith, engineer in charge of channel and harbor improvement works, at Bermuda, to meet specifically the requirements of local conditions. The draft was limited to 18 inches, and a limit of 40 feet was decided upon for the length. The breadth is 25 feet and the depth is 5 feet.

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The scow is built of pitch pine and spruce. The planking and deck is 2½ inches by 12 inches, and the framing 4 inches by 8 inches. To protect the hull from worming the bottom is covered with three coats of tar and arsenic. The cost of the scow, without drills, amounted to about $4,150 (£850).

A feature of the scow is that all exhausts are led to a keel condenser composed of about 160 feet of 2-inch galvanized pipe bolted under the bottom, and connected to a Davidson air pump, 4 inches by 6 inches by 8 inches. Although the scow is practically stationary, and the temperature of the sea water in summer is about 75 degrees F. at the surface, nevertheless a vacuum of 22 inches is easily held. The two H.9 Ingersoll-Rand drills work exceedingly well exhausting to vacuum, and the absence of exhaust steam around the work is particularly beneficial. Owing to scarcity of fresh water in Bermuda in summer, the saving of water is also a most important feature.

The scow is moved from place to place by a kedge and warp from the nigger head of the steam winch, and moorings are handled from the same, while the drum of the winch is used for hoisting boulders. There are four pitch pine spuds, 9 inches by 9 inches each, 34 feet long, and steel shod. These are also hoisted from the nigger head of the winch, and are held down by a wire down-haul pennant and fall, secured to an eyebolt on the deck.

The drills are mounted on drill frames, as shown in Fig. 3, movable fore and aft on a steel-faced track. A corrugated iron roof extends over the drill track, and steam and exhaust pipes are secured to this. Connections to the drill cylinder and feed engine are made by flexible steam hose. The powder house is located on deck at the opposite corner from the boiler house.

The longest drill used is 35 feet and shortest 10 feet. About 4 pounds of blasting gelatine are used per hole. The scow has been used in the outer portion of the channel in a moderate ocean swell, and has given very fair results, even under these extreme conditions. Owing to the fact that there is no regularity to the hard rock, it is found that the cheapest and most satisfactory method is to locate pumps and charge holes with a diver.

The boiler is of the vertical tubular type, 4 feet diameter by 6 feet 6 inches high, with 140 2-inch tubes, 3 feet 4 inches long. The steam pressure is 60 pounds gage. This boiler easily supplies steam for two drills, the air pump, a duplex pump for forcing water in the holes while drilling, and for the steam winch.

The appointment of Mr. W. B. Smith as engineer in charge of channel and harbor improvement works was made provisionally in May, 1913. At that time the output of material from the dredging operations averaged only 970 tons per week. By the following September, however, when Mr. Smith's appointment was made permanent, the weekly output had been increased to 4,500 tons. These results were attained, first, by the constant supervision of the works by the engineer in charge; second, by the addition to the equipment of the drill scow described above; and third, by encouraging harmony among the employees.

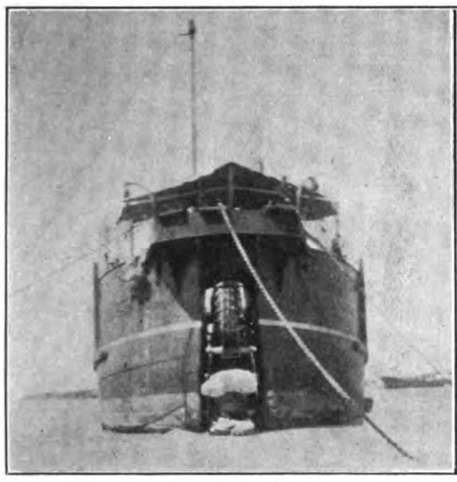


Fig. 5.—Bucket Dredger Raising Large Boulders

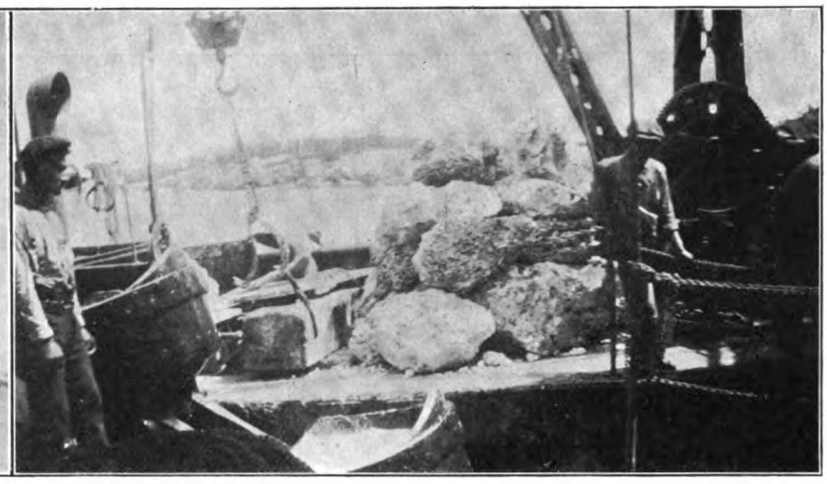
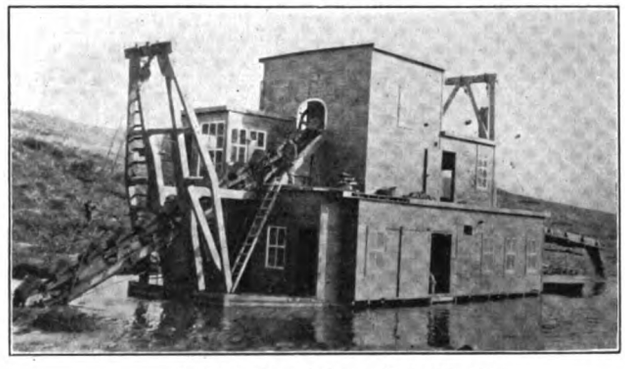


Fig. 6.—Boulders Taken from the Buckets of the *King George*

## Gasoline (Petrol) Motor Bucket Dredge

The illustration shows a 2-cubic foot bucket dredge, driven by gasoline (petrol) motive power, built by the American Dredge Building & Construction Company, Seattle, Wash., which has been operated by the Deering Dredging & Mining Company for the past two seasons on the Inmachuk River, Alaska. The dredge has worked in broken lime bed-rock, and has handled an average of 1,000 cubic yards of material per day of twenty-four hours. The dredge is of the flume type, designed to allow the installation of a screen and stacker, if so desired, and to dig 15 feet below the water level. The hull is 54 feet long, 26 feet beam and 4 feet deep. The bucket line is of the open-link type, and the buckets are made with hoods and bottoms cast in one piece of steel, with manganese side links, connecting links, bucket lips, pins and bushings. The dredge is equipped with gasoline (petrol) motive power, and centrifugal pumps are used to pump water from the pond in which the dredge is floating for washing the gravel. The flume is lined with riffles and a special design of fine gold-saving device. Several new innovations have been introduced on this dredge, adapting it particularly for recovering gold values contained in shallow creek beds. The dredge is very inexpensive and has a total shipping weight of only 100 tons. All parts are designed to permit transporation to far inland points.



2-Cubic Foot Motor Gold Dredge

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# A Simons Suction Hopper Dredger Fitted with Special Sand Trapping Apparatus

Figs. 1 and 2 show views of the 3,000-ton suction hopper dredger *Balari* constructed last year by Messrs. William Simons & Company, Renfrew, to the order of the Calcutta Port Commissioners. Owing to the great volume of drift sand and silt of very light specific gravity deposited in the Hooghly during the flood season special consideration was given to appliances which would efficiently retain this light material, and prevent a large percentage of loss in the overflow from the hopper when dredging operations were in progress. The dredger was accordingly fitted with "Simons" patent sand trapping arrangement.

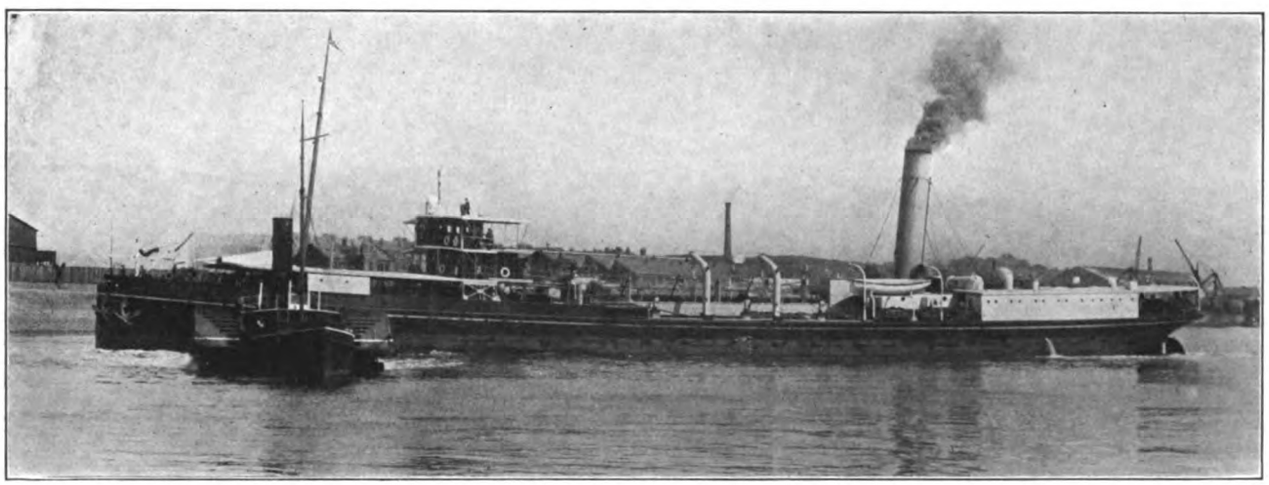

Fig. 1.—3,000-Ton Hopper Dredger *Balari*

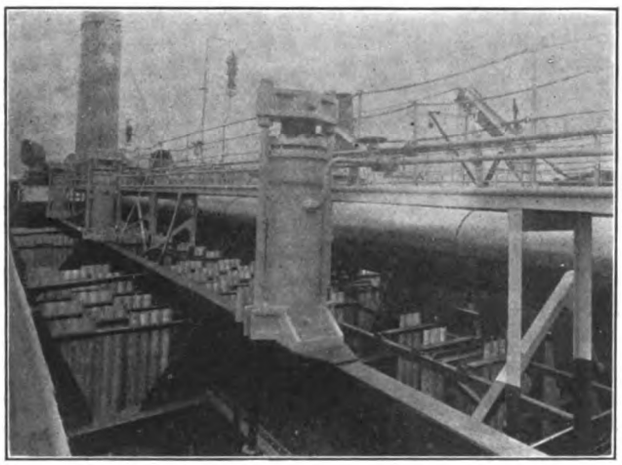

Fig. 2.—Sand Trapping Apparatus on the *Balari*

On the official trials on the Hooghly River the *Balari* filled her hopper in the remarkably short time of 19 minutes. This result was, to a very considerable extent, due to the efficiency of these sand baffling arrangements. As the loss in overflow is frequently considerable, and becomes excessive in certain classes of material when the hopper gets more than half full, it is evident that an apparatus which reduces the loss in overflow from the hopper as much as possible must materially affect the efficiency of the dredge and at the same time reduce the actual cost of dredging.

The *Balari*, which is 333 feet in length by 54 feet 6 inches beam by 22 feet 3 inches depth, has a hopper capacity of 71,600 cubic feet. The hull and machinery are constructed to Lloyd's highest class. The main deck is of steel sheathed with teak. Steam and hand steering gear is fitted, and a very complete installation of electric lighting is provided, including two searchlights.

The propelling and pumping engines are placed in two independent compartments. The propelling power is supplied by two sets of triple-expansion, surface-condensing engines, embodying all the latest improvements in marine engine practice, including steam and hydraulic reversing gear, steam turning gear, independent circulating pumps, automatic feed pumps, feed heaters and filters, large evaporators for feed-water make-up, and a complete outfit of auxiliary feed and bilge pumps. Steam is generated by four large single-ended horizontal multi-tubular boilers, constructed to Lloyd's rules for a working pressure of 180 pounds. These boilers are designed with ample surface for burning Bengal coal under forced draft. An ash ejector is fitted in the stokehold. The pumping outfit, placed forward of the hopper in an independent engine room, consists of one set of triple-expansion engines, with independent condensing plant and circulating pumps, complete with all modern fittings. The pump engines are coupled direct to a centrifugal sand pump specially designed to raise and discharge about 5,000 tons of sand and silt per hour. The pump is connected to a suction pipe placed in a well at bow of the vessel. At the upper end the pipe is fitted with a massive swivel bend, which serves as a trunnion or hinge upon which the pipe is free to move vertically. The suction end of the pipe is fitted with a specially-designed nozzle to suit the character of the material to be dredged, while a grid is also fitted to the nozzle to exclude material which might choke or damage the pump. The suction pipe is controlled by a steam winch placed on deck.

The discharge pipe from the sand pump is carried aft of the hopper.

One of the outstanding features of the deck equipment of this dredger is the extensive and powerful installation of mooring winches to regulate the movements in the rapid currents of the River Hooghly.

The bow winch has four large independent wire-rope drums for working long lengths of heavy steel wire rope. The winch is driven by a vertical high-pressure engine, the gearing throughout being of steel. In addition, at the bow, a very massive windlass is fitted having four independent cable holders and two warping ends. At the stern a large windlass is fitted having two independent cable holders and two warping ends of extra large dimensions.

A large workshop is fitted below the deck so that all gen-

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eral repairs may be effected on board. The outfit of machine tools is very complete, and consists of lathes, shaping machine, radial drill, etc., and also a smith's forge, with mechanical fan, all driven by electric motors.

## 15-Inch Hydraulic Dredge for Barge Canal Work

During the last year the Morris Machine Works, Baldwinsville, N. Y., built for Grant Smith & Company & Locher, Rome, N. Y., for use on the New York Barge Canal, a 15-inch hydraulic dredge, the general arrangement of which is shown herewith.

The hull is of wood 100 feet long by 33 feet wide by 8 feet depth, with a load draft of 4 feet 6 inches. It is of very heavy construction, and is further stiffened by two heavy steel trusses and two hogging trusses running the full length of the hull.

The machinery equipment consists of two 300-horsepower Erie watertube boilers, carrying 150 pounds steam pressure, and one cross-compound vertical engine, with cylinders 15 and 28 inches in diameter by 18 inches stroke, driving a 15-inch suction and discharge dredging pump. The shell of this pump is made of manganese steel, and the side disks of carbon steel with manganese steel lining. The pump and engine are mounted on a heavy base, which also carries a multi-collar thrust bearing of the marine type.

The winding machinery consists of a 7¼-inch by 10-inch horizontal double engine driving five drums through cast steel gearing, the ratio of gearing being 22.6 to 1. The drums are 18 inches in diameter and 18 inches long. The cutter is driven by a 10-inch by 10-inch double horizontal engine through three pairs of cast steel gearing of extra heavy proportions, the ratio of gearing being 18.6 to 1.

The auxiliaries include a double-flow surface condenser, containing 800 square feet of cooling surface; a horizontal simplex air pump, 8 inches by 14 inches by 12 inches; a 6-inch centrifugal circulating pump, directly connected to a 5-inch by 5-inch vertical engine; two duplex feed pumps, 6 inches by 4 inches by 6 inches; one duplex fresh-water pump, 5¼ inches by 4¾ inches by 5 inches, and two duplex general service

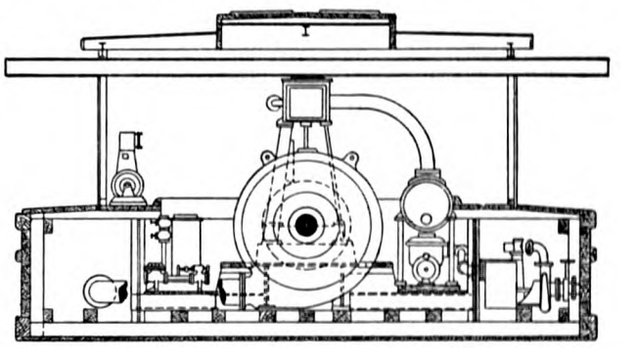

Fig. 2.—Midship Section

pumps, each 5¼ inches by 4¾ inches by 5 inches. One vertical marine type multi-coil feed-water heater, capable of taking care of 13,500 pounds of water per hour, is provided, together with a steel hot well of 270 gallons capacity, and one 6-kilowatt, 110-volt generator, direct connected to a 6-inch by 5-inch vertical engine.

The ladder is of structural steel, 57 feet long and 10 feet wide over the trunnions, with side girders of 7/16-inch plate 30 inches deep. The cutter is of the built-up type, with six blades of special steel, actuated by a shaft 6 inches in diameter enlarged to 7 inches through the suction head.

The suction pipe is of lap-welded construction, 15 inches inside diameter, with the flanges welded on. The suction pipe enters the hull at the upper end of the ladder through steel swivel trunnions of the Morris type, provided with both

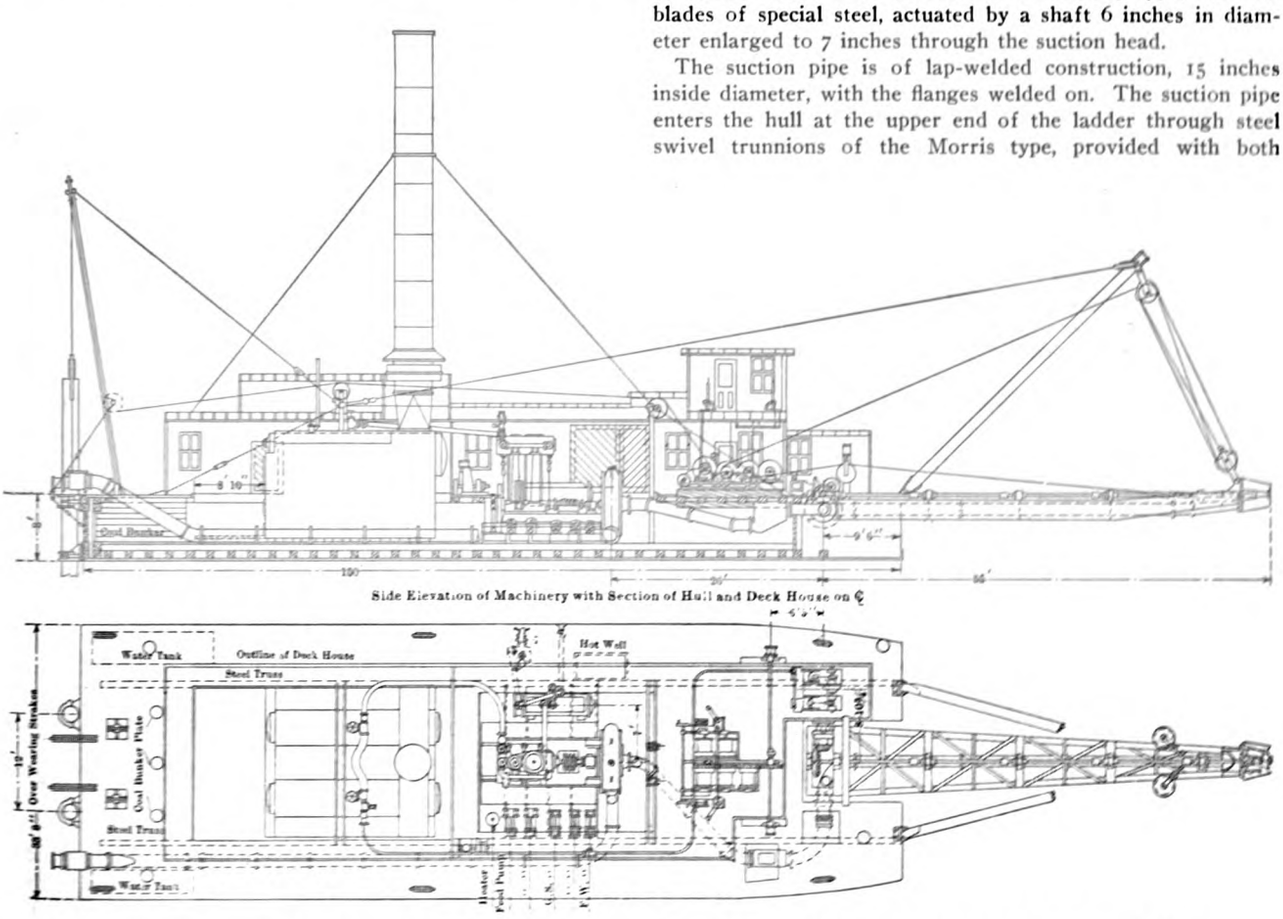


Fig. 1.—15-Inch Hydraulic Dredge that Handles an Average of 425 Cubic Yards of Material per Hour on Barge Canal Work

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packing gland and water seal to insure absolute air tightness under all conditions. The trunnion joint is entirely above water, accessible at all times, and so designed that all parts subject to wear can be easily and quickly renewed.

The elbows connecting with the suction pipe are of cast steel of extra long radius. The angle at which the ladder can dig is not limited as with a ball joint. The outer end of the ladder my be lifted high out of the water and placed on banks or on a high side scow, or in case of breakage of a wire in the ladder fall, with the dredge in deep water, the ladder may swing down and back under the dredge without doing any harm. With the ball-joint construction the range is limited both up and down, and in case of breakage very serious damage may result.

The spuds are of wood 23 inches in diameter, having 5,000-pound points on the lower ends. The spud frame is built up of structural steel, and, as is the case with the ladder "A" frame, another frame projecting above the deck-house roof is hinged at the bottom, so that in case of necessity they can all be laid flat to permit passing under bridges.

The spud keepers are of cast steel, and are fastened to the stern of the dredge. They are made in halves, so that by simply removing a pin the gate can be swung open and the spuds removed without the necessity of lifting them up to clear the top keeper, as is the case with spud keepers built in the hull.

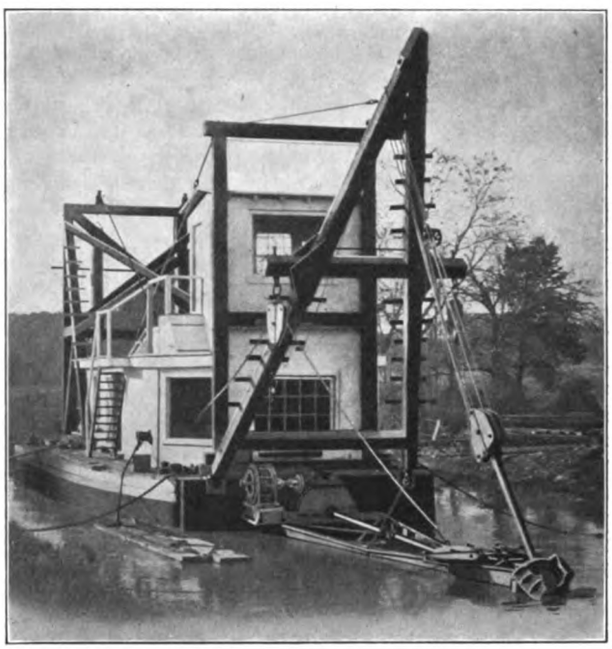
All wires for raising spuds and ladders are kept up overhead, where they can at all times be inspected or lubricated and at the same time be properly guarded.

This dredge is working on contract No. 46 of the New York State Barge Canal, and began operation July 1, 1913, working in two 8-hour shifts, or a total of sixteen hours per day. During the first month the dredge was in operation the actual operating time was 365 hours out of a possible 416 hours, or a total of 12 percent lost time for the month. When considering the time lost in changing shore and pontoon lines, swinging cable, cleaning the stone-box, etc., it can be seen that the actual lost time per month, due to any part of the machinery, is a very small percentage indeed. During this time the dredge handled in all 155,000 cubic yards, but as the channel was dug 2 feet below grade the paid yardage was only 145,000 yards. The dredge accordingly handled material at an average rate of 425 cubic yards per hour. The best performance for any 8-hour run was on July 8, when 5,200 yards were excavated, or an average of 650 yards per hour. At the same time the static head remained practically constant, being from 8 to 10 feet. The shortest discharge pipe-line was 1,475 feet, and the longest pipe-line 2,750 feet. The average rate of pumping for six months' operation, with the dredge in operation only sixteen hours per day, is about 102,000 yards per month.

## An Electric Suction Dredge for Canal Work

A growing demand for utilizing the advantages of the electric current in operating hydraulic dredges has brought out a number of electrically-driven dredges. Practically all dredge designers agree that the steam-driven dredge offers the greatest "flexibility" in operation, and that the presence of steam under pressure is an advantage for a great many purposes, such as heating, for priming the main dredging pump, etc. Yet the absence of coal, and thereby coal barges, tenders, firemen, etc., tends to lessen the cost of operation where current can be had conveniently and at a moderate price. The comparatively high speed of the electric motors as compared with steam engines necessitates a greater speed reduction, and here is where the efficiency of the design will show up to advantage during continuous operation.

An example of a successful electrically-driven hydraulic dredge is shown in the illustration. This is a 10-inch dredge built for the Fredericksburg Power Company, of Fredericksburg, Va., by the Norbom Engineering Company, of Philadelphia, Pa. The power company owns a comparatively narrow canal, which is over fifty years old and partly filled up with silt. The canal is on the average 40 feet wide and 4 to 6 feet deep. The dredge was procured to clean it out, as well as to deepen it to 12 feet and to widen it to about 75 feet. Strong cutter machinery was needed on account of the hard loam or clay to be encountered, and the pump was designed



Electrically-Driven Hydraulic Dredge

to deliver the material to points sometimes 1,500 feet away against a lift of about 6 to 10 feet.

The main pump is fitted with a 36-inch runner, belt-driven, from a 150-horsepower General Electric motor (25-cycle, three-phase, 2,200-volt, 750 revolutions per minute). Speed variation, as needed to meet the various heads under which the pump must work, is provided by exchanging pulleys of different sizes on the motor. For priming the pump an exhauster working under a water pressure of 50 pounds was provided in a manner similar to the ordinary steam ejector, the pressure water being provided by a plunger pump driven from a 5-horsepower motor; this same motor is also driving a smaller auxiliary pump, which provides a stream of water for the purpose of flushing the stuffing-box on the main pump and the cutter shaft bearings, as well as water-sealing the ball joint on which the suction pipe is hinged. This ball joint is so made that can be packed and water-sealed, and takes up wear automatically.

The speed reduction on the winding machinery and cutter machinery from the 15-horsepower and 30-horsepower motors installed, is direct through a set of worm and worm-wheel running in oil in an enclosed casing, thus insuring noiseless operation. All necessary auxiliaries needed for the convenient operation of this dredge have been provided, and it seems that in consideration of the fact that the first cost of such a dredge is far less than that of a steam dredge, and under average conditions the cost of operating is also less, there should be no real objection to the electric dredge wherever the power can be had. Furthermore, the power is paid for as consumed, while on a steam dredge a large quantity of fuel, whether coal or oil, must be ordered in advance, and often paid for long before it is all consumed.

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# Powerful Bucket Dredgers Built in Canada

**The Largest Bucket Dredgers Ever Built in Canada Delivered to the Government this Year for Operation in the St. Lawrence Ship Channel**

The Collingwood Shipbuilding Company, Ltd., Collingwood, Ontario, has completed two powerful bucket dredgers of the central well type for the Canadian Government's Department of Marine and Fisheries. These vessels are the largest of this type ever built in Canada, and are intended to operate in the St. Lawrence Ship Channel. The principal dimensions are as follows:

| | |
|---|---|
| Length between perpendiculars..... | 215 feet |
| Breadth, molded ..... | 37 feet 6 inches |
| Depth, molded ..... | 14 feet |

They are built under Lloyd's special survey to take 100-A 1 dredger class and under government inspection. The dredging gear and propelling machinery are of exceptionally heavy design, in order to cope with the hard pan and rock which is encountered in many parts of the St. Lawrence River. The ladder is of very substantial construction, 117 feet long, and arranged to accommodate a chain of 40 buckets, each of 27 cubic feet capacity. The buckets have cast steel backs, heavy boiler plate bodies and manganese steel lips, and each one is provided with four heavy cutting teeth with tool-steel points. The bucket links are forged and the pins and bushings are of manganese steel. The tumblers are of cast steel, the bottom one being six and the top one five-sided. To stand the wear and tear the bottom tumbler shaft is fitted with a hard steel liner and a manganese steel bush in halves. When the ladder is at an angle of 45 degrees the dredge can dig to a depth of 52 feet below the water level.

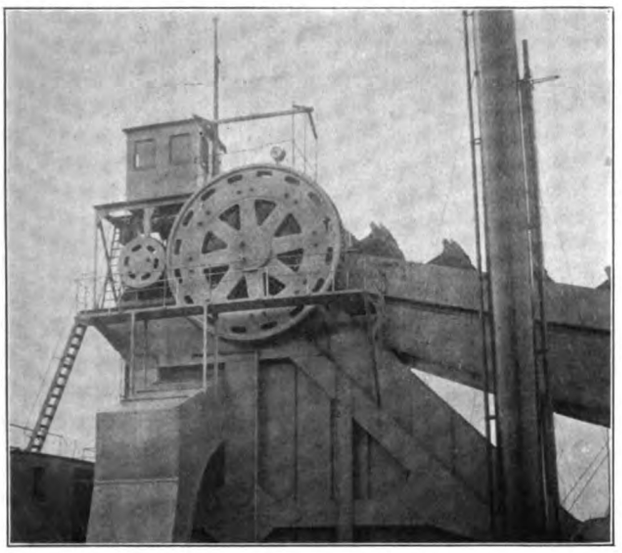

Fig. 1.—Gearing for Operating Buckets

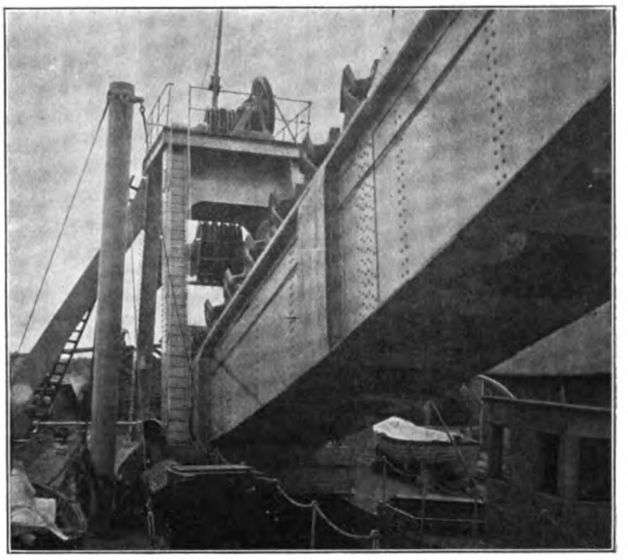

Fig. 2.—Lifting Tackle

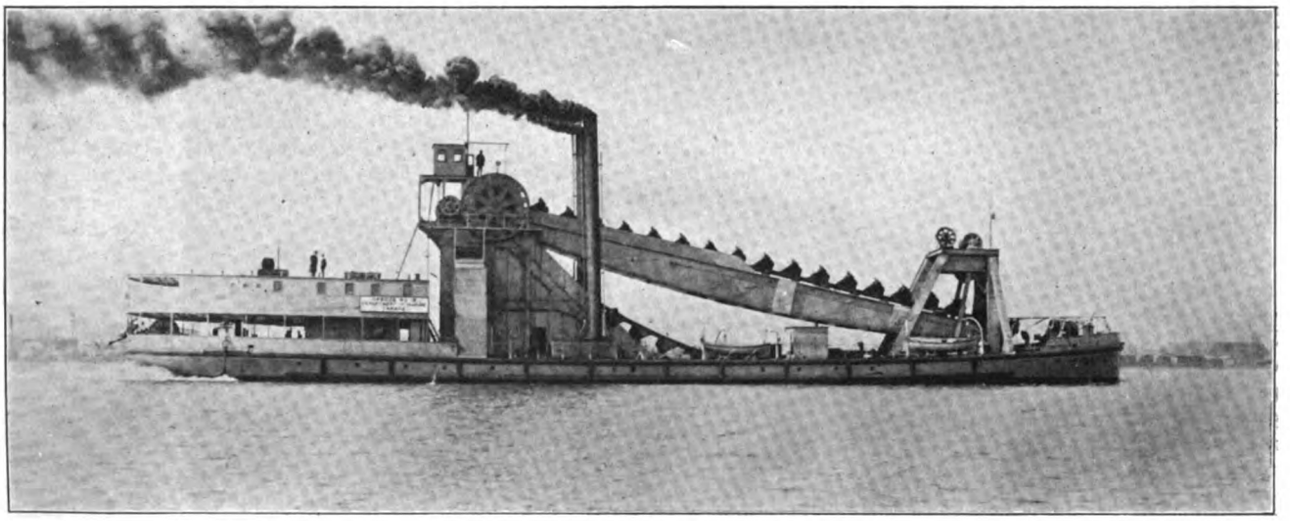

Fig. 3.—Central Well Bucket Dredger, Built by the Collingwood Shipbuilding Company, Ltd., for the Canadian Government's Department of Marine and Fisheries

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### PROPELLING MACHINERY

The propelling machinery consists of one set of triple-expansion, surface-condensing engines of the Collingwood Shipbuilding Company's make, with cylinders 15 inches, 25 inches and 42 inches diameter by 26 inches stroke. A clutch is arranged between the crankshaft and propeller in order to disconnect when the vessel is digging. Forward of the engine a heavy change speed gear arrangement is fitted, having a double clutch so as to give two speeds on the chain of buckets, the low speed being 10 to 12 buckets and the high speed 18 to 20 buckets per minute, the latter speed being intended when dredging in soft material. The vertical shaft driving the top gears and surge wheel is 11 inches diameter, and all the gears and pinions are of cast steel. The surge wheels are each 15 feet 6 inches diameter, the outer rim having double helical teeth. The friction is arranged by means of brass-faced cod pieces and tightening screws.

The boilers are of the usual marine type, two in number, 11 feet 6 inches diameter by 10 feet 6 inches long, fitted with Howden's forced draft, and arranged to work at a pressure of 180 pounds per square inch.

### AUXILIARIES

A very complete installation of engine room auxiliaries has been fitted, and comprises a 10-inch by 20-inch by 10-inch vertical monotype air pump, one pair of direct-connected feed pumps, 7 inches by 5 inches by 15 inches, one vertical duplex general service pump, 7½ inches by 4¾ inches by 10 inches, one 6-inch centrifugal circulating pump, two vertical simplex bilge pumps, 6 inches by 5 inches by 10 inches, two vertical duplex sanitary and feed-water pumps, 4½ inches by 4 inches by 5 inches, one G. & J. Weir's surface feed heater, one See's ash ejector in each boiler room. A complete electric installation is fitted, consisting of two 11-kilowatt machines, either one of these being capable of handling all the lights aboard the vessel. A 24-inch diameter searchlight of 25,000 candle-power is fitted on the shade deck aft for use in reading draft gages on the river at night. A 60-inch Howden's fan is fitted for supplying the necessary forced draft to the boilers.

The deck auxiliaries consist of one 9-inch by 18-inch bow winch, situated on a flat under the main deck with special lead for chains through a hatch on the upper deck. The drum of the winch is designed to accommodate 4,000 feet of 1½-inch steel wire rope and 300 feet of 1½-inch chain. There are also one 9 inch by 16-inch stern winch and two 9-inch by 16-inch breasting winches, the latter having drums arranged to handle the port and starboard wires. Each winch is capable of accommodating 4,000 feet of 1¼-inch wire rope and 300 feet of 1¼-inch chain cable. Six anchors are fitted for working the vessel—one bow, one stern and four breasting. These are of the ordinary type with stocks, and are of suitable weights for securely mooring the dredge when working.

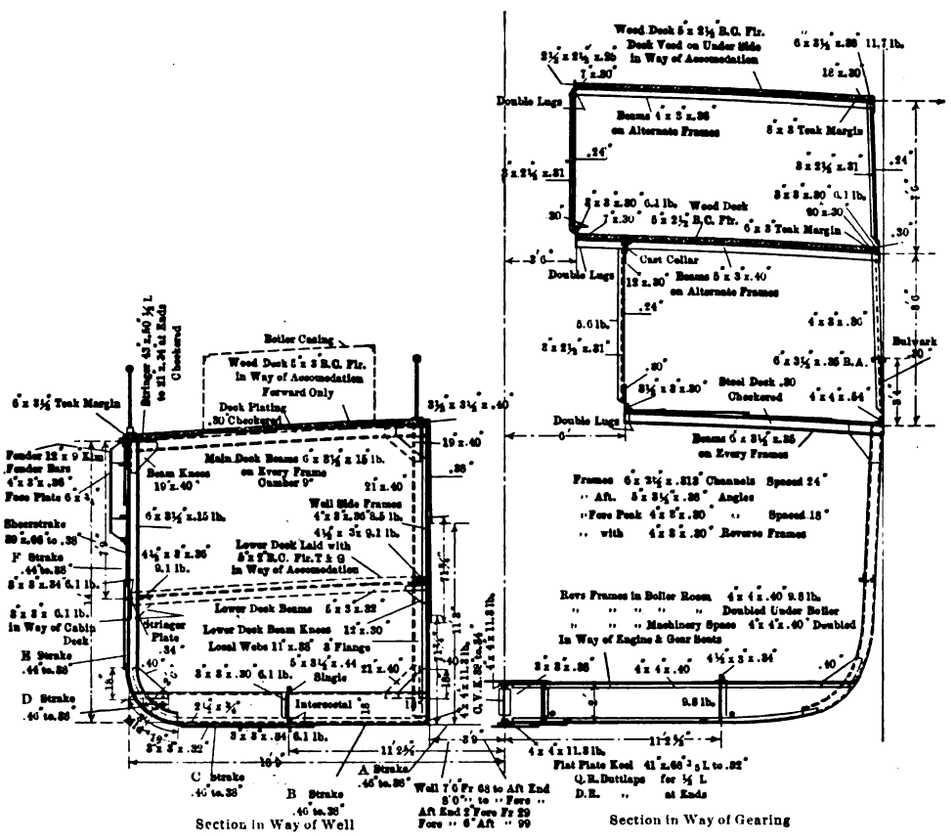


Fig. 4.—Midship Section

A very powerful engine and drum has been installed in the lower hold on the starboard side for handling the very heavy bucket ladder and its equipment. The engine is of the vertical type, with two cylinders 14½ inches diameter by 13 inches stroke, and, like the deck auxiliaries, operates with steam at 90 pounds.

### LADDER GEAR

The hoisting rope is of special plow steel, 1¾ inches diameter, and the drum on the hoisting engine has been made large enough to accommodate all the rope without riding. In addition to the main hoisting rope steel wire preventers 2¼ inches diameter are fitted to each side of the bucket ladder for use should anything go wrong with the side rods.

The hoisting sheaves are cast steel, 4 feet 6 inches diameter, specially arranged to take the above cable, the bottom and top blocks having five sheaves each, while a special idler sheave is

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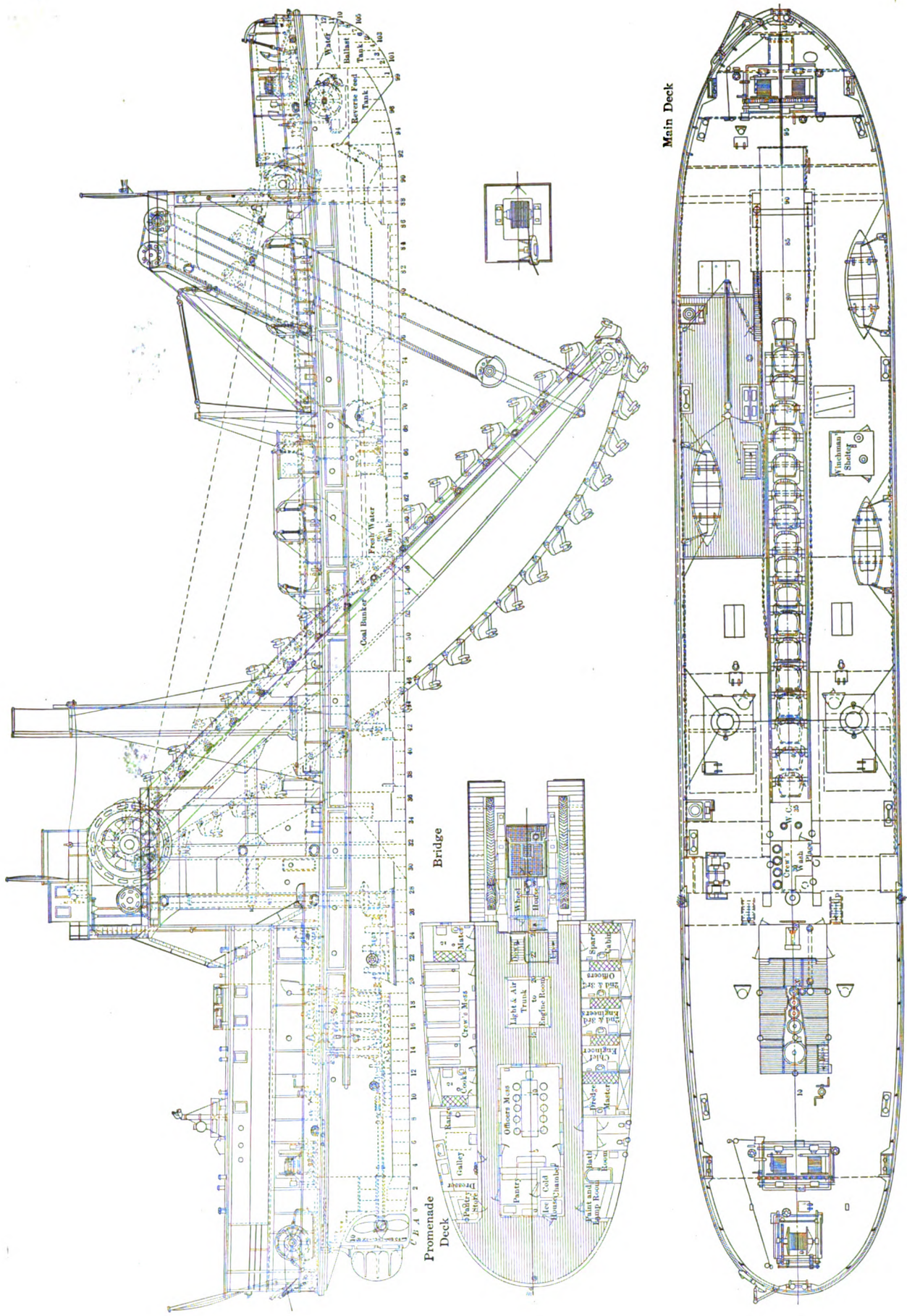


Fig. 5.—Profile and Deck Plans of Collingwood Dredge

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fitted on the top of the bow shear legs. These shear legs and the main framing have all been specially designed to take care of the heavy strains which come on them owing to the massive design of the bucket ladder and the other dredging gear.

A winch 6 inches by 8 inches has been installed on the port side to handle the side chute. One side chute only has been fitted, but arrangements have been made so that in the event of the vessel having to discharge on the starboard side a chute could readily be installed. For handling barges two 8-inch by 8-inch capstans have been installed on the main deck on the port side.

The steering gear consists of a 5½-inch by 5½-inch steam engine, situated on the upper deck inside the engine casing, the customary lead of chains, spring buffers, quadrant, etc., have been fitted. The gear is also arranged to operate by hand.

A steel derrick post with steel derrick is fitted on the port

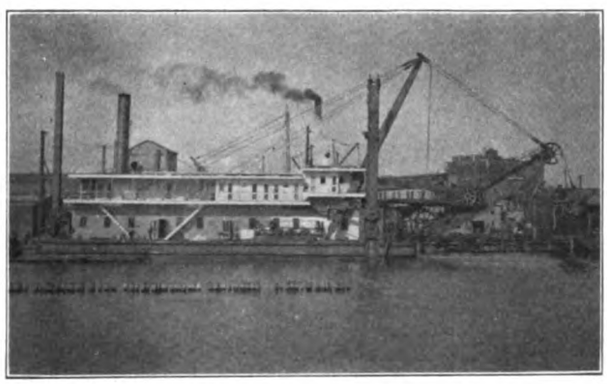

Fig. 1.—Panama Dredge *Paraiso* under Test at Port Richmond, N. Y.

side of the main deck, and arranged in such a way that it can readily handle the bucket when these have to be changed. It is also arranged to serve the hatch over a workshop which has been fitted on the lower deck forward.

### ACCOMMODATIONS

The accommodation for the dredging master and officers is fitted on a promenade deck aft, and has been designed to give as much light and air as possible. The crew are accommodated with large rooms on the lower deck forward. These vessels usually work day and night throughout the season of navigation, and therefore accommodation for a double crew has been provided. Suitable galley, pantry, storeroom and lavatory accommodation has been installed, as shown on the accompanying plans.

The forepeak has been arranged for water ballast, and a reserve feed tank has been fitted immediately aft of this for use in case the vessel operates in salt water. Fresh-water tanks are incorporated with the ship's structure just forward of the coal bunkers.

Both ships were practically completed last autumn, but could not be delivered before the close of navigation owing to the poor delivery of important materials, and had, therefore, to be held until the opening of navigation this year. The first vessel successfully carried out digging and speed trials on April 23 and 24, under the supervision of Mr. McNab, assistant naval constructor; Mr. Forneret, chief engineer of the St. Lawrence Ship Channel, and Mr. Steadworthy, dredge master. The horsepower developed was 950 at 120 revolutions per minute, using steam at 180 pounds per square inch, which is well over the specified requirements. The trials of the second vessel, completed May 6, were equally successful, and both vessels left for the voyage to Sorel, P. Q., a distance of over 1,000 miles, on May 9.

## Two New Dipper Dredgers at Panama

The *Gamboa,* the first of the two new 15-yard dipper dredges purchased by the Isthmian Canal Commission from the Bucyrus Company, started digging at the base of Hagen's slide on the west bank of Culebra Cut on April 3, and by the

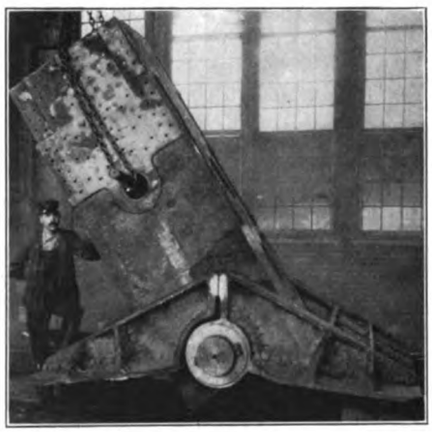

Fig. 2.—Spud Foot of the Panama Dredge

time this issue reaches our readers it is expected that the second dredge, the *Paraiso,* will be in action.

These dredges were fully described in our last dredge number. Suffice it to say that they are the largest dredges of their type that have ever been constructed. They are equipped with

Fig. 3.—15-Yard Dipper, with 34 Men Standing on Platform Inside

dippers of two capacities, one of 10 cubic yards for rock work, and one of 15 cubic yards for average digging.

An idea of the tremendous size of these machines may be gained from Fig. 3, which shows the 15-yard dipper. A platform has been suspended half-way down this dipper on which thirty-four men have been grouped. The dredges are de-

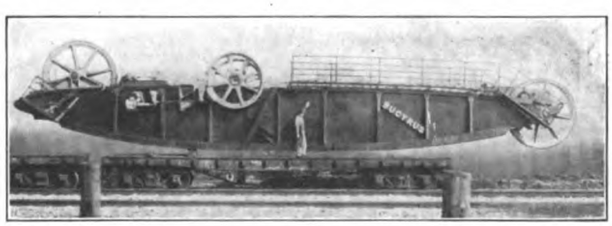

Fig. 4.—Boom for 15-Yard Dredge

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signed to dig to a depth of 50 feet below the surface of the water. The booms are 62 feet long and weigh about 113,000 pounds apiece, complete with machinery. The dipper handle is 72 feet long and weighs 81,000 pounds.

The dredges were built at Newburg, N. Y., and towed down the Hudson River to Port Richmond, S. I., where they were erected and tested. Here they were again partially dismantled and towed to the Isthmus, the booms, handles, dippers and heavy parts being shipped separately on vessels of the Panama Railroad Steamship Line.

## Powerful Bucket and Suction Dredgers for Russia

The bucket barge loading dredger *No. 2* illustrated in Fig. 1 is one of two dredgers delivered last year by Messrs. Simons, Renfrew, at Reval, to the order of the Russian Imperial Government. This dredger is fitted with two sets of com-

Fig. 1.—Bucket Barge Loading Dredger No. 2

pound surface-condensing engines, each driving its own propeller. Steam is supplied by two steel multi-tubular boilers, constructed to Lloyd's requirements for 120 pounds working pressure. The engines are arranged to give two speeds of buckets, so that either set is available for driving the dredging gear. The bucket ladder is designed for dredging the vessel's own flotation and to a depth of 40 feet below water level. The bucket dredging capacity is 1,000 tons per hour.

These dredgers have been engaged in very onerous work. Each of them has raised many large boulders ranging in

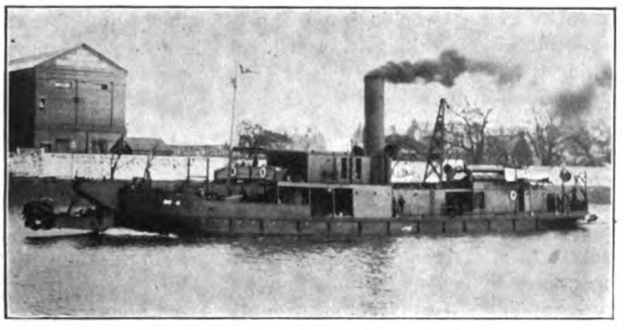


Fig. 2.—Suction Cutter Dredger No. 4

weight up to 5 tons without suffering in any way from the shocks inevitably sustained when dredging in hard ground largely mixed with massive boulders.

Fig. 2 illustrates the "Simons" cutter suction dredger *No.* 4, which these builders are on the eve of despatching to Russia.

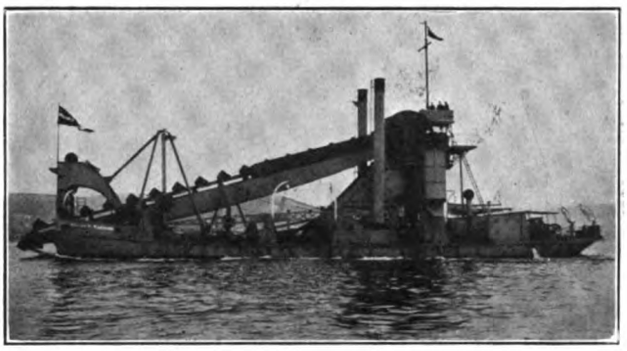
The dredger is fitted with two sets of compound surface-condensing engines, each driving its own propeller. Steam is supplied by two steel multi-tubular boilers constructed to Bureau Veritas requirements for 160 pounds working pressure. The dredging pump is driven by an independent set of triple-expansion surface-condensing engines. The cutter is driven from a set of vertical compound engines through cast steel gearing of very massive construction. The suction frame is designed for dredging the vessel's own flotation and to a depth of 40 feet below water level. The dredging and discharging capacity is 1,000 tons per hour. *No.* 5, a sister ship, is designed to dredge to a depth of 65 feet.

## Bucket Ladder Dredger William H. Raeburn

Messrs. Ferguson Bros., Ltd., Port Glasgow, have just completed a self-propelling bucket dredger, named *William H. Raeburn,* for the Clyde Lighthouses Trustees. She is of the bow-well center bucket ladder type, 150 feet long by 34 feet beam and 12 feet depth, built to Lloyd's highest class.

Side shoots are arranged for discharging the dredged material over either side of the vessel into hopper barges, the lifting and lowering of each shoot being worked by an independent engine. The regulation of the spoil to either side of the vessel is controlled by a strong, flat valve door fixed at the apex of the shoots and worked by gear from the main deck.

Separate accommodation is provided below decks for the captain, engineers, crew and ladder men, all fitted up in first-class style, special provision being made for light and ventila-



Bucket Dredger *William H. Raeburn*

tion. The steering gear is fitted on the bridge, which is placed at the highest point of the dredger on top of the main gear framing.

The main engines, which are employed for either propelling the vessel or driving the dredging gear, consist of one set of compound surface-condensing, inverted, direct-acting engines. An auxiliary condenser is fitted to deal with steam from the winches, etc. Steam is supplied from two cylindrical return multi-tubular boilers, constructed under Lloyd's special survey.

The bucket ladder is suspended independently of the upper tumbler shaft. Two sets of buckets are supplied, one for soft and one for hard material. The gearing is arranged to work the buckets at two different speeds according to the nature of material being dredged. All wheels, pinions, clutches, tumblers and bucket backs are of cast steel. The upper tumbler shaft is driven by two friction spur wheels of large diameter, and capable of being adjusted to convey the necessary power to the buckets according to the hardness of material being worked. The hoisting gear for the bucket ladder consists of a heavy wire-rope tackle, working in upper and lower sheave blocks suspended from a crosshead fixed on a box framing structure built into the forward end of the vessel. The lower sheave blocks are connected to the bucket ladder by strong forged side rods. The wire rope is wound on a large grooved

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barrel driven by gearing from a double-cylinder engine, all placed below the deck. The dredging buckets and links are of a special strong design, each bucket having a capacity of 21 cubic feet. The connecting pins for bucket chain are of manganese steel.

Three powerful steam winches are fitted, two at the bow and one at the stern, for manipulating the mooring chains and holding the dredger up to its work. Each winch is driven by a two-cylinder engine. The dredger is capable of a speed of about 7 knots.

## Sea-Going Hopper and Suction Dredger

The dredger illustrated, which has excellent sea-going qualities, made the voyage from the builders' works, Werf Gusto, Firma A. F. Smulders, Schiedam, to the Dutch East Indies under her own steam.

She has the following dimensions:

| | |
|---|---|
| Length between perpendiculars..... | 229.6 feet |
| Breadth, molded ..... | 36.1 feet |
| Depth, molded ..... | 16.4 feet |
| Hopper capacity ..... | 24,724 cubic feet |
| Dredging depth..... | 16 to 32 feet |

each provided with a derrick; the derrick of the foremast is capable of lifting 8 tons up to a height of 10 feet above deck with an outside range of 8 feet, while the mainmast derrick has a lifting power of 4 tons. These two masts are provided with steam winches, while there is a towing hook aft of the vessel.

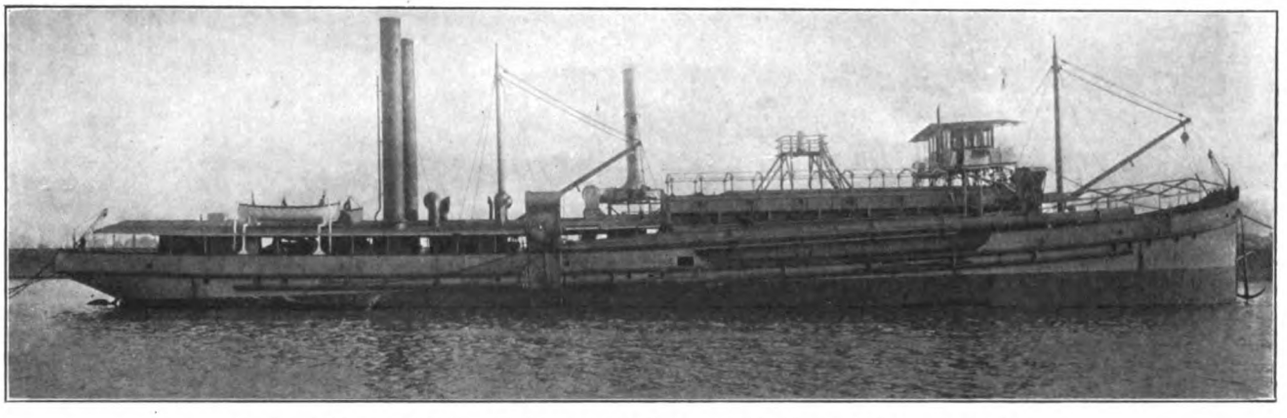
The dredger is provided with two separate sand pumps, having the various suction and force pipes so arranged as to be capable of working as follows:

First, to suck from the bottom while navigating to a depth of from 16 to 32 feet by means of one central suction pipe; fill her own hopper, dumping the spoil by the bottom doors.

Second, to suck from the bottom with the starboard sand pump to a depth of from 16 to 82 feet by means of a lateral suction pipe; fill her own hopper or the barges moored alongside or force the spoil ashore by a floating pipe-line. In the latter case the starboard and port pumps can be coupled in series, in order to force the spoil to a greater distance.

Third, to suck from her own hopper, discharging or forcing the spoil as described in the second instance.

The vessel is provided with a complete electric light installation. The dynamo is capable of feeding the two arc lamps, placed on deck, each of 1,000 candle-power, as well as



Sea-going Suction Dredger, Built by Werf Gusto, for Service in the Dutch East Indies

Her speed when loaded is 8½ knots in calm water with and against a current, with a coal consumption of 1.87 pounds per indicated horsepower per hour, deduction being made for ashes and cinders.

The hull is built entirely of Siemens-Martin mild steel, according to the prescriptions of the Bureau Veritas and under its special survey. The hull is divided into thirteen compartments by means of watertight bulkheads, extending to the deck and provided with sluice valves for pumping the bilge water.

The steam engines operating the propellers and the sand pumps are of the triple-expansion type, and each set is provided with a separate surface condenser, while there are two sets of separate engines to operate the air, circulating, feed and bilge pumps. The two engines operating the propellers have each a capacity of 450 indicated horsepower, making 165 revolutions per minute, each driving a propeller. The sand pumps are actuated by two triple-expansion engines, each developing 280 indicated horsepower, making 200 revolutions per minute.

Steam is supplied by two cylindrical marine boilers with return flame, each with two Morison furnaces, executed according to the rules of Bureau Veritas and having each a heating surface of 1,775 square feet, working at a pressure of 173 pounds per square inch.

The vessel has the necessary installations and accommodation for the European and native crew. There are two masts,

the necessary incandescent lamps for the cabins, engine room, stokehold and the lighting of the deck.

The bottom doors of the hopper are closed by means of two rods and chains operated by two hydraulic cylinders.

The sand pumps are capable of filling the hopper, which has a capacity of 24,724 cubic feet within about ten minutes with solid stuff when working in clayish soil, the two sand pumps sucking from the bottom by means of the central suction pipes with trailing suction head.

NEW MUNICIPAL FERRYBOAT MAYOR GAYNOR.—The *Mayor Gaynor,* built by the New York Shipbuilding Company, Camden, N. J., and recently placed on the New York Municipal Ferry Service between Manhattan and Thirty-ninth street, South Brooklyn, is 231 feet long over all, 45 feet 8 inches beam, molded at the deck; 64 feet beam over guards and 18 feet 6 inches molded depth. Propulsion is by a four-cylinder triple-expansion engine, with cylinders 21½, 33, 39 and 39 inches diameter by 30 inches stroke, designed to develop 1,950 indicated horsepower at 150 revolutions per minute. Steam is supplied at 225 pounds working pressure by three Babcock & Wilcox watertube boilers. The auxiliaries include an electric lighting equipment, consisting of two direct-connected generators of 25 kilowatts each. The designed speed of the ferryboat is 14 miles per hour.

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# Large Electrically-Operated Gold Dredge*

**Details of the Construction, Equipment and Operation of the Latest and Largest, All Steel Electrically-Driven Gold Dredge**

BY W. H. GARDNER AND W. M. SHEPARD

The gold dredge is essentially a hull or scow on which is mounted excavating machinery, screening and washing appliances for the recovery of the gold, and an arrangement for depositing the waste material sufficiently far behind the dredge as not to interfere with its flotation and operation. The dredge excavates material at its front end, extracts the gold and deposits the waste material behind it, continually moving forward and carrying its own pond with it, thus working any fairly level deposit independent of its elevation or proximity to the river or stream. A continuous influx of fresh water through a ditch, varying from 40 to 200 miners' inches,[1] depending on the kind of ground and the size of the dredge, counterbalances the losses through seepage or evaporation, and serves to settle the suspended clay and silt.

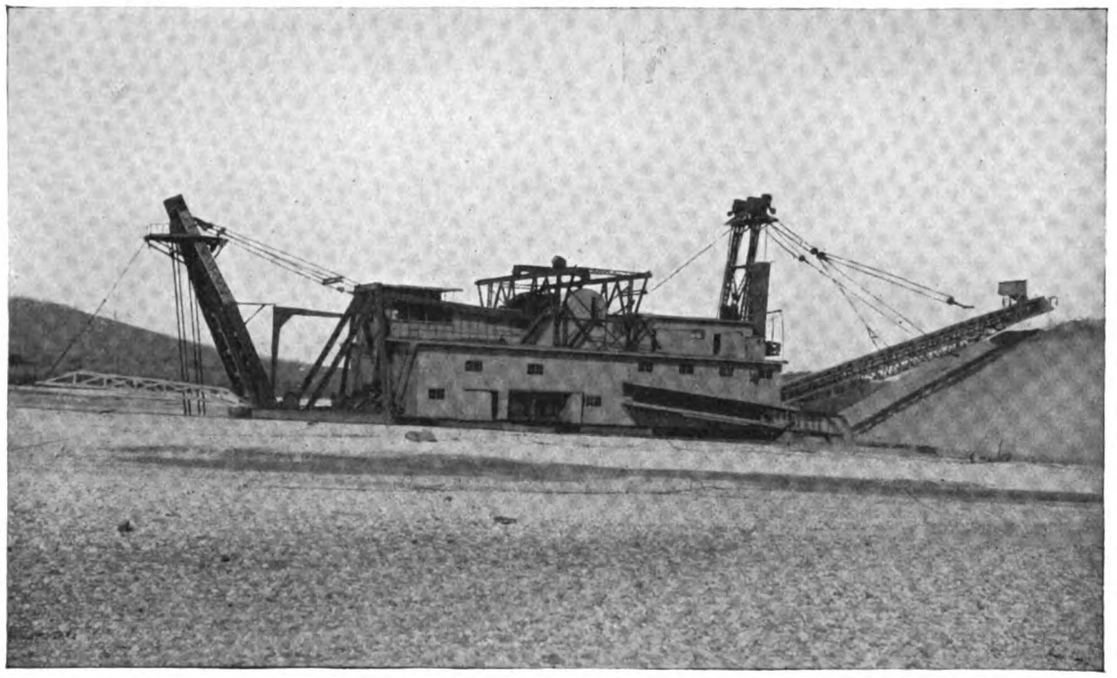

Fig. 1.—A View of the Yuba Gold Dredge No. 14 in Operation

The excavation is done by means of an endless chain of heavy buckets, revolving over two tumblers mounted at the extremities of a long ladder, the upper tumbler being six-sided and acting as a positive driving sprocket for the bucket chain. In modern installations the lower tumbler is round, acting as an idler or sheave. The ladder is suspended at its lower end from a heavy gantry on the bow of the dredge hull, the raising and lowering of the ladder controlling the digging depth. The elevation of this ladder is controlled by a winch, called the ladder hoist winch, situated on the port side of the dredge. The lateral motion of the buckets is secured by swinging the entire dredge on one of the "spuds" as a pivot. This is done by means of lines run from two drums, the "swing winch," on the starboard side, connected through sheaves on the port and starboard bow to "dead men" on the banks. The continuously revolving bucket line is thus swung across the face of the bank for a width of from 190 to 300 feet, and at the extreme lateral limit of the swing the ladder is dropped and the side swing repeated. The revolving buckets thus terrace away the bank until bed-rock is reached, when the ladder is raised, the dredge stepped forward by swinging on alternate spuds, and the whole operation recommenced. These spuds, which are single sticks of lumber on the smaller dredges and of structural steel on the larger and more powerful dredges, are at the stern of the dredge and suspended from the stern gantry. On the *Yuba No.* 14, which is described in this article, these spuds weigh over 40 tons each, and are 60 feet long.

The ascending buckets, full of gold-bearing material, are dumped over the upper tumbler into a hopper lined with heavy-wearing bars, where it is subjected to high-pressure sprays of water. The gravel is then delivered to the screen, a revolving cylinder sloping toward the stern and lined with perforated steel plates, in which it is continuously played upon by jets of water and is completely disintegrated. The sand, fine gravel, and gold particles are washed through the perforations into the distributor under the screen which serves to properly distribute the mass onto the gold-saving tables. These are in two banks, an upper and a lower, and are composed of fore and aft and 'thwartship sluices, lined with steel-shod sugar pine riffles, where the gold is caught and amalgamated by mercury. The waste sand is delivered from the tail sluices at the stern of the dredge, some of it

* From the *General Electric Review.*

[1] A miner's inch is approximately estimated at 1½ cubic feet per minute.

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being deposited around the spud points to enable them to obtain a firmer hold, and the remainder dumped at some distance behind the dredge. The boulders and heavy gravel, which do not pass through the perforations, fall from the rear end of the screen into a chute, and are thence delivered onto the stacker belt. This endless belt carries the material up a long stacker, which is hung from the stern gantry of the dredge, and is finally dumped far to the stern, forming the extensive "rock piles" characteristic of a dredging field.

All these operations are controlled by three men. The winchman, in the "winch" or operating room above the swing

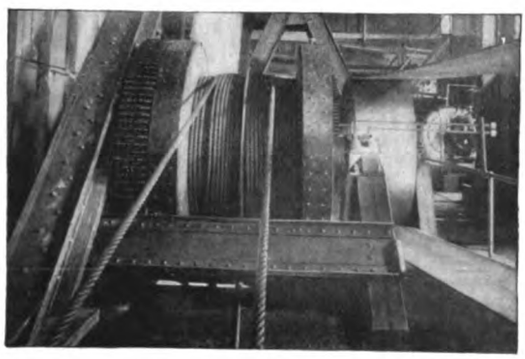

Fig. 2.—Ladder Hoist Winch

winch, commands a view of the line of buckets and controls the principal motions of the dredge. Two oilers are employed, one of whom attends to the control of the screen and stacker, and they complete the necessary crew for a shift.

In 1912 the construction of *Yuba No.* 14, at present the last word in modern gold dredge construction, was first projected. It was determined to build this dredge entirely of steel, the longer life and practically negligible fire risk being the determining factors. The life of a dredge is limited by the life of its hull, and the steel hull, while more expensive, increases the life of the dredge from ten years, with a wooden

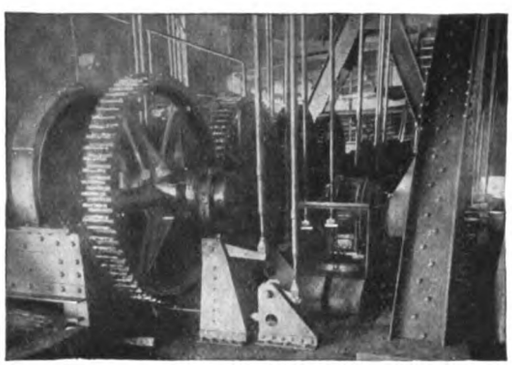

Fig. 3.—Eight-Drum Swing Winch

hull, to fifteen years or more. Steel housing and steel gold-saving tables were provided to decrease risk of loss by fire and for other reasons. Buckets of 16-cubic-foot capacity each were designed, the expected yardage being 10,000 cubic yards per day. A long ladder was planned, to enable the dredge to dig 70 feet below water level and reach the deepest bed-rock. The latest improvements in electrical equipment and control were incorporated in the plans of the dredge, to help reduce the operating cost to a minimum. An increased area of gold-saving tables was provided to secure the maximum gold recovery. While no experimental features were introduced in the design, the machinery was strengthened in many places. As a result *Yuba No.* 14 stands as the largest and most advanced gold dredge in the world.

*Yuba No.* 14 was designed and constructed by the Yuba Construction Company, of Marysville, Cal. It was built on the Yuba River, California, about 14 miles from Marysville.

### STEEL HULL

Perhaps the most important and interesting feature of *Yuba No.* 14 is its steel hull. This hull is 155 feet 6 inches long, 58 feet wide, with an additional overhang of 5 feet on

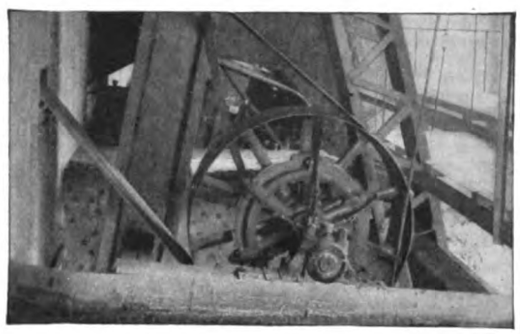

Fig. 4.—Screen Drive

each side to increase the deck area, and is 11 feet 6 inches deep. It is made entirely of steel, and is the first steel-hull dredge to have a deck of steel plating. Particular attention has been given to the design of the hull. It has been so constructed that all of the heavy stresses are distributed over a series of fore and aft and transverse trusses. The vertical sides of the hull form the girders which carry the concentrated loads near the edges of the main deck. The bottom of the hull is framed in such a way that the upward pressure of the water is carried to the main fore and aft trusses and to the sides, allowing the hull to be as light as possible, and yet

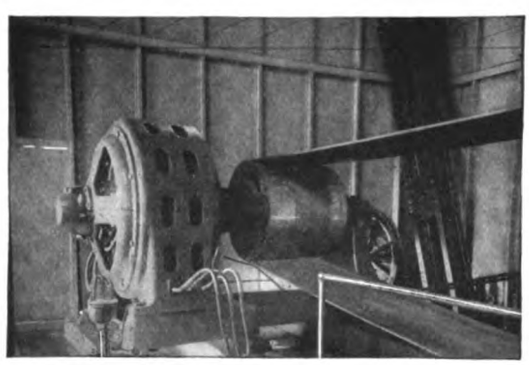

Fig. 5.—400 Horsepower Induction Motor, Operating Buckets

giving it at the same time ample strength to withstand the stresses incident to the operation of the dredge. Following out this same scheme, the spuds are directly in line with the fore and aft trusses.

The bow gantry, the truss from which the ladder is suspended, is of particularly heavy steel construction, and the weights of the bow and stern gantry, added to the weight of the hull, show a grand total of 1,562,546 pounds.

The housing, carrying out the general plan of the dredge, is also of steel fireproof construction. It is made up of two sheets of 22-gage steel, between which is a ¼-inch sheet of

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millboard. This insures absolute fire protection, and gives a maximum insulation, keeping the dredge interior warm in winter and cool in summer. This is an important item, for warm weather in the field is particularly torrid owing to the gravel and sand bars along the river.

### DIGGING LADDER

The digging ladder, of the plate girder type, is one of the heaviest yet designed, and to enable the dredge to dig 70 feet below water level has a length of 133 feet 6 inches between tumbler centers. This girder is 10 feet in depth. Not counting the ladder rollers or bucket line, this ladder weighs 125 tons.

The bucket line is composed of 87 buckets, connected in an endless chain. The bucket bottoms are of a special nickel-chrome steel, cast with the hoods integral. The lips and bushings are of manganese steel, and the bucket pins are of a specially heat-treated oil-tempered nickel-chrome steel. The steel plates, is 50 feet 6 inches in length and 9 feet in diameter, and is stiffened by heavy longitudinal steel angles extending between the supporting tread rings at each end.

The gold-saving tables and supports are made entirely of steel, and divided into two separate tanks 6 feet apart. In each bank there are fourteen transverse sluices on each side of the dredge. The three upper sluices extend through the side of the house, where each one discharges into separate outboard longitudinal sluices that extend to the stern. The other eleven cross sluices discharge into seven inboard longitudinal sluices, the discharge from which is carried about 25 feet astern by overhanging steel tail sluices, or delivered back of the spuds as may be required. The total table area is 7,540 square feet.

### SPUDS

The two spuds are built up of structural angles and plates, have a cast steel point, are 30 inches by 60 inches in section and 60 feet long, and weigh together 160,800 pounds.

**Fig. 6.—A View of the Yuba Gold Dredge, Showing the Digging Ladder Raised**

wear on the bucket line of a deep-digging dredge is very great, and hence only the highest grade steels can be used in its construction. This bucket line complete weighs very nearly 203 tons, a weight of over 4,600 pounds per bucket.

### LADDER HOIST WINCH

The ladder hoist winch, Fig. 2, is operated by the main motor through a pulley shaft on the main deck, this shaft being also belted to the main bucket drive above. The main digging motor, which is of 400 horsepower, is thus used to raise and lower the ladder and to drive the bucket line.

The main drive, consisting of the upper tumbler shaft with its two 12-foot diameter gears, the intermediate shaft, which is made in two separate lengths to allow room for the long hopper, and the pulley shaft, with its two differential pinions and 12-foot diameter pulley, is rigidly supported by the steel main gantry and the upper chords of the fore and aft main trusses, this rigidity serving to hold the gears accurately in mesh and to preserve the alinement of the shafting.

### SCREEN

The screen, a revolving cylinder of perforated high carbon

The stacker is exceptionally long, measuring 137 feet between pulley centers, for when digging to the maximum depth of 70 feet the boulders have to be stacked very high. As is usual, it is of the lattice truss type.

### SWING WINCH

The swing winch, Fig. 3, is an eight-drum winch, two of the drums being for spares (lines which are used for repair work and miscellaneous purposes), two for the bow swinging lines, two for the lines that raise the spuds, and two for the stern lines. This winch weighs 41 tons. The design of winches of this type has been worked out particularly well, and in spite of continuous use and hard wear, repairs on such a winch are wonderfully small.

### PUMPS

Since *Yuba No.* 14 will not dig with a high bank, as do some of the Natomas Consolidated Dredges, no monitor pump is carried. There are, however, three Yuba construction pumps, one a 14-inch high-pressure horizontal centrifugal pump, used for supplying water to the screen, one a 14-inch low-pressure pump, used for supplying water to the tables,

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and the third, a 6-inch two-stage pump, supplying water under a 125-foot head to the dump hopper.

By a system of levers, the motion of the drums on the swing winch, the speed change on the same winch, and the operation of the main drive clutch, the ladder hoist clutch, the ladder hoist brake, and the main drive brake, are all controlled from the winch room, requiring a total of twenty-three levers. These are in addition to the control of the main drive and swing winch motors. From the winch room the bucket line can be raised or lowered, stopped or set in motion, the spuds can be raised or lowered, and the dredge moved by either the bow swing, head or stern lines.

### Electrical Equipment

The electrical equipment of *Yuba No.* 14 is of interest, in that it represents something of a departure from the equipment heretofore considered standard for California gold dredges. This departure from former practice was made in the light of experience gained in the operation of four dredges of the largest type, which were built by the Yuba Construction Company for the Natomas Consolidated, of California, and one similar dredge built for the Yuba Consolidated Gold Fields.

Power is supplied by the Pacific Gas & Electric Company, and is three-phase, 60-cycle, 4,000-volt.

The power is brought on board the boat through 750 feet No. O B. & S. gage, three-conductor cable. This cable is insulated for 4,500 volts working pressure. The shore cable is brought aboard the dredge on pontoons, and enters a switch house on the upper deck near the stern of the dredge, where there is installed an automatic 300-ampere, 7,500-volt oil switch with hand-operated remote control. There are installed in this switch house two 4400/110-volt, 200-watt potential transformers with fuses, and two 150-ampere current transformers. The secondaries of these transformers are connected to indicating instruments mounted in the winch room. From the switch house the current is fed through triple-conductor varnished cambric cable in conduit to the primary side of the main transformers. These consist of three 200-kilowatt oil-cooled transformers, 4,000-volt primary and 460/230-volt secondary. In addition to the main transformers, there is installed one 15-kilowatt 4,000-volt primary, 230/115-volt secondary oil-cooled transformer to supply lights. From the secondary side of the main transformers various feeder circuits supply the different motors, triple-conductor varnished cambric being used in iron conduits.

The control panel for the main drive, or digging motor, and for the winch motor, is located in the winch room, as is also the instrument panel. The instrument panel contains instruments the readings of which give the total input to the dredge.

The panels for the pump motors are located on the lower deck, the starting compensators for the pump motors being mounted alongside the panels. These compensators are all provided with inverse time-limit relays. The stacker and screen motors are controlled from independent panels located in the stern of the dredge.

### Digging or Main Drive Motor

This motor, which is shown in Fig. 5, operates the digging mechanism. It is a 400-horsepower, 514-revolution per minute, 3-phase, 60-cycle, 440-volt, slip-ring, variable-speed induction motor with three bearings, pulley and sliding rails, with a master controller and contactor panels, and is provided with resistance good for continuous operation at all speeds from 50 percent normal to normal.

The contactor equipment is provided with current limiting relays, which limit the maximum load that the motor can take, and so protect both the motor itself and the complete digging mechanism that it drives. This is of considerable importance in keeping down the cost of repairs and preventing loss of time incident to repairs. The digging mechanism is subject at times to sudden and excessive loads, and without the current-limiting feature provided by the contactor control the only protection would be given by the overload oil switch. Due to the annoyance of having this switch tripping out frequently it is usually set so high as to afford little protection. The current-limiting relays also protect the motor and digging mechanism when starting. The winchmen can throw the master controller to the full "on" position, and the motor will come up to speed at a predetermined rate, which will not impose excessive stress on any part of the mechanism.

### Winch Motor

This motor operates the winch, raises the spuds, and swings the boat, and consists of one 35-horsepower, 600-revolution per minute, 3-phase, 60-cycle, slip-ring, variable-speed induction motor, with a controller and resistance for continuous operation at from 50 percent to full speed. The motor is provided with pulley and base. In a few instances on smaller dredges, motors of intermittent rating were furnished for operating the winch. These motors, however, have not been found suitable for this service, as the winch operates almost continuously.

### Pump Motors

All the pump motors are squirrel-cage motors, the high-pressure pump having a 150-horsepower, 600-revolution per minute motor, the low-pressure pump a 75-horsepower, 600-revolution per minute motor, the 6-inch two-stage pump a 50-horsepower, 1,200-revolution per minute motor, and the vertical pump a 10-horsepower vertical motor. These motors are all direct connected to the pumps, and, with the exception of the 10-horsepower motor, are all provided with welded end-ring construction in the rotor.

### Screen and Stacker Motors

These motors are of the slip-ring, variable-speed type, provided with resistance for continuous operation at from 50 percent to full speed and with reversible controllers. They operate at 600 revolutions per minute, the screen motor being 75 horsepower and the stacker motor 60 horsepower. In most of the former gold dredges these motors were of the constant-speed squirrel-cage type. However, in the more recent large dredges, due to difficulties sometimes experienced with squirrel-cage motors on account of the heavy starting conditions and the desirability at times of running for short periods at reduced speeds, slip-ring motors with resistances for two-minute starting duty were used. In heavy work, however, these were found too light, and for *Yuba No.* 14 resistances for continuous operation were installed and reversible controllers used.

There is provided a 2-horsepower, 1,800-revolution per minute, 3-phase motor with pulley and base for the repair shop on board the dredge.

### Power Consumption

The operating time of a gold dredge is between 85 and 88 percent of the total time. The dredge operates night and day with three shifts. The load factor varies from 62 percent to 80 percent, depending on the character of the ground, and as the dredge operates practically every day in the year throughout its life, except the Fourth of July and Christmas, it represents an excellent load for the power company.

*Yuba No.* 14 was built in four months and four days from the driving of the first rivet, a remarkable time considering the enormous total weight of the dredge. All material was transported 14 miles from the railroad over uncertain roads by means of power tractors and trailers, by no means a small job when it is noted that the completed dredge weighs very close to 1,994 tons.

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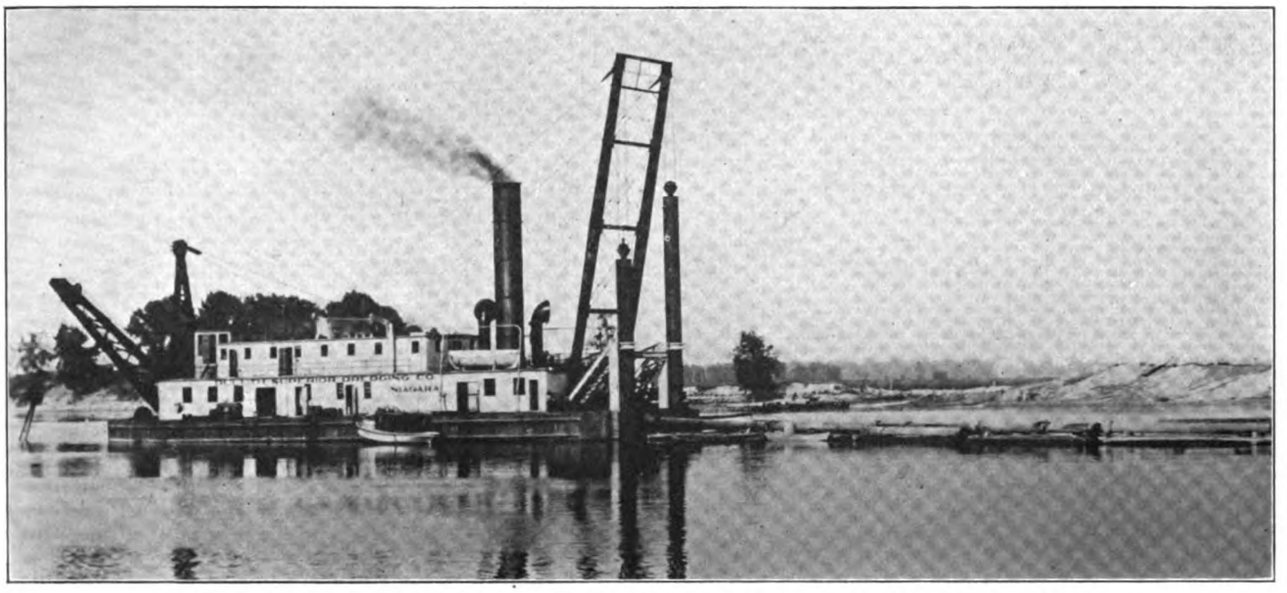

Fig. 1.—20-Inch Hydraulic Dredge *Niagara*, Operated by a 1,000 Horsepower, Triple-Expansion Engine

## Digging Hard-Pan with a Hydraulic Dredge

In the last annual dredge number of INTERNATIONAL MARINE ENGINEERING, which was published in May, 1913, a detailed description was given of the design of the 20-inch hydraulic dredge *Niagara*, owned by the Duluth Superior Dredging Company, and built by the Bucyrus Company, of South Milwaukee, Wis. At the time this article was published the dredge was still under construction, but during the last year it has been at work in the Saginaw River, Michigan, and we are now able to give some details of its operation.

This dredge marks the latest advance in the design of a high-powered hydraulic dredge for very heavy service. It may be recalled that the machinery is driven by a 1,000-horsepower triple-expansion vertical marine type engine, operating at a speed of 200 revolutions per minute for pumping material through a 5,000-foot pipe-line elevated to a height of 10 feet above the water. In order to enable it to handle the hardest kind of material and to take care of the extremely high-water pressure developed, the pump is of special design. Exclusive of the engine it weighs 71,000 pounds, and is made of special Bucyrus nickel-chrome steel. The cutter driving machinery, it is claimed, is the heaviest ever put on an hydraulic dredge of this size, being a 12-inch by 15-inch double engine.

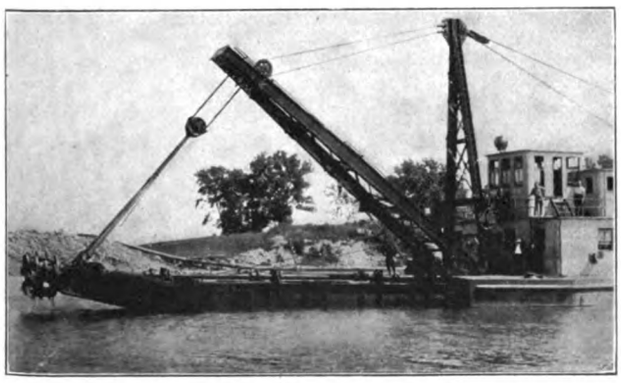

Fig. 2.—Cutting Ladder

The contract for dredging the Saginaw River between Bay City and Saginaw, Mich., was let by the United States War Department to George H. Breymann & Bros., Toledo, Ohio. The work was divided into two sections; Section 2 being sub-let to the Duluth-Superior Dredging Company, of Duluth. The total excavation amounts to over 4,000,000 cubic yards, of which 3,375,000 cubic yards are included in Section 2. The channel which is being excavated extends from the 18-foot curve in Saginaw Bay to the junction of the Tittabawassee and Shiawassee Rivers, a distance of 21¼ miles, and is to be 200 feet wide at the bottom and 18 feet in depth. The material encountered on Section 2 consists, for a distance of about 10 miles, largely of sand and clay; for the remaining 6 miles it is a very hard indurated clay or hard pan with a large quantity of stone of various sizes, very compact. The Duluth-Superior Dredging Company are working two 20-inch hydraulic dredges, the *Niagara*, mentioned before, and the *Enterprise*. The former is being used on the hard material on the lower end of the section, and the latter in softer digging, working from the middle up towards the upper end of the section.

Fig. 3.—Cutter Head

The general plan of execution is similar to any other hydraulic dredging job. The material excavated from the

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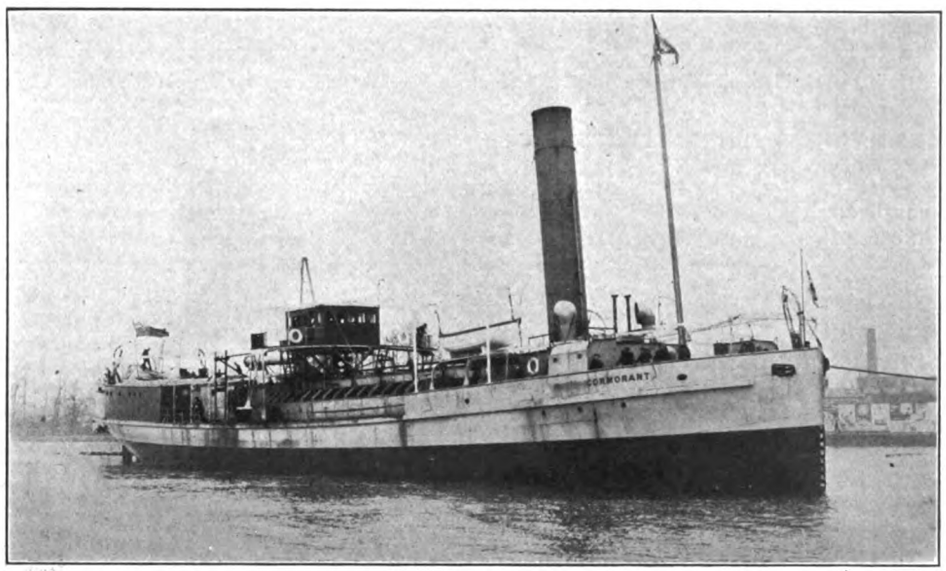
channel is pumped onto the bank of the river to form a levee upon which is to be built a road connecting the cities of Saginaw and Bay City. The *Niagara* started digging on June 5, 1913, and was kept at work until it was laid up for the winter on Dec. 23. During this period it worked 3,018½ hours, and was delayed for various reasons 1,008½ hours. All but 193 hours of the time charged to delays was consumed in shifting pipe-lines and in the other usual operations which necessitate stopping the pump. Of this 193 hours, the major portion was due to the wearing out of the pump casing and parts of the section and discharge pipes which pass through the hull, due to the unusually hard character of material pumped.

During this working season the dredge excavated a channel 14,600 feet long to a depth of about 17.5 feet, with an average width of 235 feet. The maximum depth of cutting was 7.4 feet, and the total amount of material removed 910,000 cubic yards, of which 730,323 was pay material, the remainder being taken outside of specified channel lines. The dredge *Enterprise* dug 940,000 cubic yards between April 22 and Dec. 13.



Drag Suction Dredger *Cormorant*

## Trials of a Unique Drag Suction Dredger

The "Simons" drag suction dredger *Cormorant*, shown in the accompanying illustration, was delivered by Messrs. Simons & Company, of Renfrew, at Rangoon this year to the order of the Rangoon Port Commissioners for service in improvement work on the Rangoon River.

The *Cormorant* is fitted with a suction and discharge pump capable of raising and discharging 2,000 tons of material per hour. The dredging results obtained on the Clyde trials were very considerably in excess of the contract requirements, and the speed was found to be half a knot in excess of the specification.

Triple-expansion surface-condensing engines are fitted for driving the propellers or pumping outfit, as may be required. Steam is supplied from two cylindrical multi-tubular boilers, constructed for a working pressure of 160 pounds per square inch.

The main centrifugal pump is connected to a suction frame fitted in a central well at the stern, and powerful water jets are arranged on the nozzle at the bottom of the suction frame.

The hopper doors are controlled by powerful hydraulic gear, the power being supplied from one duplex set of steam pressure pumps. The hopper arrangements include "Simons" patent suction apparatus, which enables the load in the hopper to be discharged overboard for reclamation purposes, as well as through folding doors in the bottom by the ordinary method.

The "Simons" patent steering jets and "Simons" patent sand baffling arrangements are special features of this dredger, and the efficiency of both of these arrangements was amply demonstrated at the trials. In the teeth of a very strong wind the dredger was put on a mark and kept on a straight course for fully fifteen minutes solely by means of her hydraulic steering jets without any assistance whatever being rendered by the steering gear. With the starboard propeller running at full speed and with the port jet at full work the dredger was brought round against the propeller. Again, when all the way was off and the vessel at a standstill, a complete circuit was made by means of the steering jets.

The sand trapping arrangements with which the dredger was fitted were also found to be very efficient in reducing loss in the overflow from the hopper to a minimum when dredging light, silty material. It should be added that by the operations of the "Simons" drag suction dredgers a uniform and level bottom is obtained.

## A Sea-Going Twin-Screw Barge-Emptying and Suction-Loading Dredger for Tientsin, China

An interesting barge-loading and suction-loading dredger, which has been built by Messrs. A. F. Smulders, of Schiedam, Holland, for the Hai-Ho Conservancy Board, Tientsin, China, is illustrated on page 247. This vessel has a length between perpendiculars of 124 feet 8 inches, a breadth of 32 feet 10 inches, and a depth of 10 feet 8 inches. It is capable of discharging spoil into barges alongside or through either a floating pipe-line, 1,000 feet in length, or a shore delivery pipe-line over a distance of 9,800 feet, and may be used as a suction dredger, working either at side anchors or in motion, and as a stationary pumping station for the discharge ashore of the spoil out of barges.

When pumping while in motion the dredger is arranged for discharge over either side into barges towed alongside, or through an opening in the bow, to which opening a floating pipe-line is fitted when dredging at side anchors. For balancing the vessel the shore delivery pipe-line is fitted on the port side, while the barge suction is usually effected over the starboard side. The suction pipe for direct dredging at anchor is provided with a suction mouth, armed with a sleeve, so

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fitted as to avoid clogging when dredging a furrow 8 feet deep in easily collapsible earth. When the dredger is in motion the suction pipe is capable of reaching to a depth of 20 feet, and when dredging at anchors with a different suction mouth of reaching to a depth of 25 feet. The normal service speed is approximately 8 knots.

The hull is of Siemens-Martin steel, and built in accordance with Bureau Veritas rules and under special survey. It is divided into seven watertight compartments.

The two compound double-crank engines, with surface condensers for propulsion, each develop 250 indicated horsepower at normal speed. One of these is arranged to be uncoupled from the propeller shaft and coupled to a 22-inch water pump for the supply of water when the dredger works as a pumping station. The engines are fitted with link motion and reversing gear.

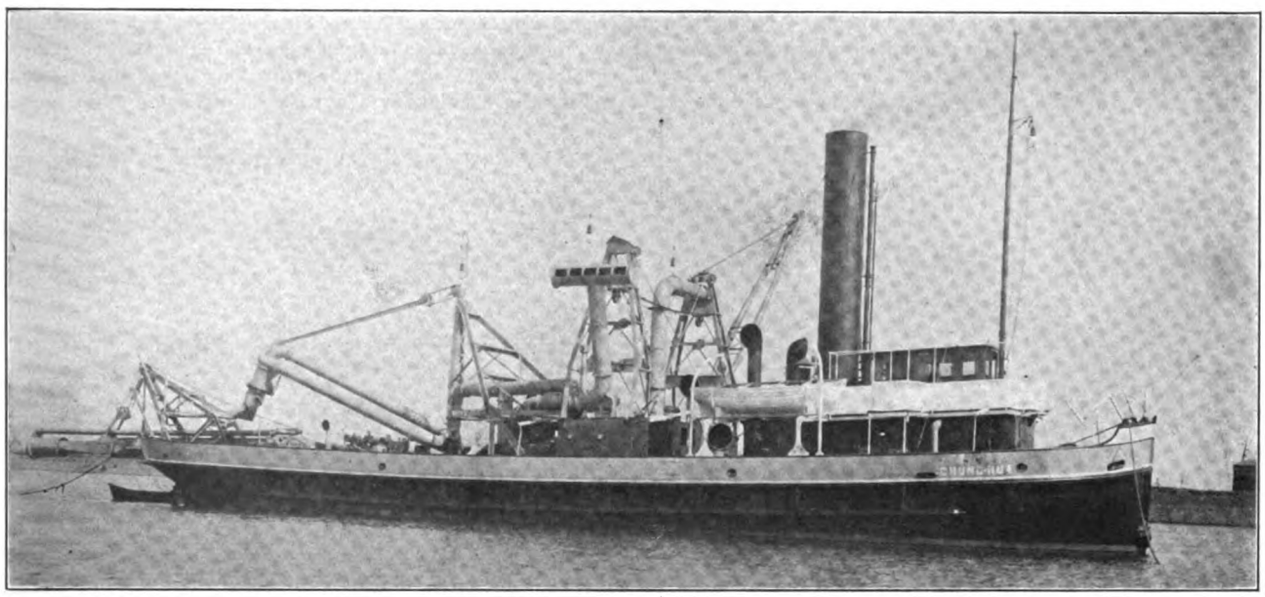
One compound double-crank engine, with surface condenser, developing 500 indicated horsepower when working at normal speed, is placed amidships for driving directly two sand pumps, working compound when emptying barges for shore delivery. The exhaust steam of the auxiliary engines is discharged in the condenser of the sand-pump engine.

The stern pump draws from the 24-inch suction pipe for direct dredging or from the 20-inch suction pipe for barge emptying. A stone-catching box is placed between the sand pump and the suction pipes; the mixture is delivered overboard into barges on either side or through the floating pipeline. An elbow is fitted instead of a pipe when the mixture has to go to the second sand pump, when both are working in compound for shore delivery. One compound, double-crank, high-speed engine drives directly a three-stage centrifugal pump for delivering water at the suction mouth at a pressure of 100 feet water column.

The main boilers, two in number, are of the marine type with return flues, and have a heating surface of 1,500 square feet each. The working pressure of the boilers is 120 pounds. A donkey boiler is fitted with a heating surface of 100 square feet, also working on a pressure of 120 pounds.

On deck are the suction pipe hoisting gear, the maneuvering winches, anchor davits, etc. An engine and dynamo of 100 volts, of sufficient power for six arc lamps and the necessary 16-candlepower incandescent lamps in the crew space, cabins, engine and boiler compartments, are fitted. Searchlight apparatus is provided, to be occasionally used instead of some of the arc lamps. When working as a pumping station the dredger discharges the spoil over a distance of 9,800 feet through a 24⅜-inch pipe-line, and delivers, by means of the sand pumps, 1,236 cubic feet of water a minute at 150 revolutions of the engine; while for the water pump the output is 1,271 cubic feet of water a minute with 160 revolutions of the engine. When dredging at anchors and discharging through a 1,000-foot floating pipe-line of 20 inches diameter, using one sand pump, the duty for the sand pump is 1,059 cubic feet a minute with 160 revolutions of the engine, while, when dredging in motion and delivering into barges alongside, the output of the sand pump is 2,471 cubic feet of water a minute with 150 revolutions of the engine.

This dredger is the ninth vessel which Messrs. Smulders have supplied to the Hai-So Conservancy Board. It would appear at first sight that in China manual labor for dredging would be much cheaper than mechanical work, but, despite the fact that Chinese labor charges are five times lower than in Europe, mechanical appliances have proved to be much below the cost of manual labor. This difference is brought about not only by reason of the high power developed in the dredging plant, but also by reason of the fact that coal is 50 percent cheaper in China than in Europe, and also the weather does not affect the general expenses with dredging machinery so much as human labor.



The *Chung-Hua*, A Dutch Built Dredger for China

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MONTHLY SHIPBUILDING REPORTS.—The Bureau of Navigation, Department of Commerce, reports 118 sailing, steam and unrigged vessels of 40,326 gross tons built in the United States and officially numbered during the month of April. Of this total, eleven were steel steamships aggregating 28,152 gross tons. The largest vessel built during the month was the *Iowan* of 6,649 gross tons, built by the Maryland Steel Company, Sparrows Point, Md., for the American-Hawaiian Steamship Company.

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LAUNCH OF THE HOWARD M. HANNA, JR.—The Great Lakes steamer *Howard M. Hanna, Jr.*, was launched at the Cleveland yards of the American Shipbuilding Company May 9. The dimensions of the vessel are 525 feet length over all, 54 feet beam, 30 feet depth, deadweight capacity 9,000 tons. The vessel will be operated by W. C. Richardson & Company.

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# The Powerful Rock-Lifting Dredger Cowpen

**A Twin-Screw, Stern-Well, Bucket Hopper Dredger of 1,600 Horsepower Built for Service in Deepening Blyth Harbor**

A powerful twin-screw stern-well bucket hopper dredger was completed towards the end of April, 1913, by Messrs. Ferguson Bros., Ltd., Port Glasgow, for service at Blyth Harbor, on the northeast coast of England, where a very comprehensive scheme of deepening and other improvements is now being proceeded with. The deepening of the harbor and entrance channel at Blyth involves the removing of a considerable amount of rock, consisting of hard sandstone intermixed with veins of metamorphic rock and large numbers of boulders.

The new dredge is 205 feet in length between perpendiculars, 41 feet breadth, molded, and 16 feet 9 inches depth, molded. She is capable of cutting her own flotation and dredging in any depths from her own flotation level down to 50 feet. The bucket ladder, 112 feet in length, projects beyond the hull a distance sufficient to enable the dredger to work close up to dock and quay walls when the buckets are lowered to a depth of 40 feet.

The hull is subdivided into 12 watertight compartments; the two sides of the hull at the after end of the vessel, where the bucket ladder projects, are strongly connected by raised framing constructed with heavy girder beams and strong bracing plates carried across the vessel above the ladder well. This framing is of a height to insure the sag of the chain of buckets being above the bottom of the vessel. The bucket ladder and box framing for supporting the chain of buckets and dredging have been constructed of the best class of girder work, all put together and efficiently connected with steel rivets closed by hydraulic pressure. A side shoot is arranged for discharging the dredged material over the starboard side of the vessel into the hopper barges, the lifting and lowering of the shoot being worked by an independent engine. The regulation of the spoil into the vessel's own hopper is controlled by 3 strong flap valve doors fixed in the hopper shoot and worked by gear from the main deck.

Separate accommodation is provided under the deck for the captain, engineers, crew and ladder men, fitted up in first-class style, and having a very complete outfit, special provision being made for light and ventilation. Steam steering gear is fitted on the bridge placed over the hopper. A complete installation of electric light is fitted throughout, large arc lamps being placed on deck for night work. The compartments at the forward end of the hopper are arranged as coal bunkers and boiler-feed tanks. The bucket ladder is suspended independent of the upper tumbler shaft.

The main engines which are employed for either propelling the vessel or driving the dredging gear consist of two sets of triple-expansion surface-condensing inverted direct-acting type, having 3 cranks and capable of indicating 1,600 horse-power; they are fitted with steam reversing gear, and have auxiliaries embodying all the latest improvements. Steam is supplied from two cylindrical return multitubular boilers, constructed under Lloyd's special survey. The dredging machinery is of massive design for working in the hardest materials that can be dealt with by bucket dredgers.

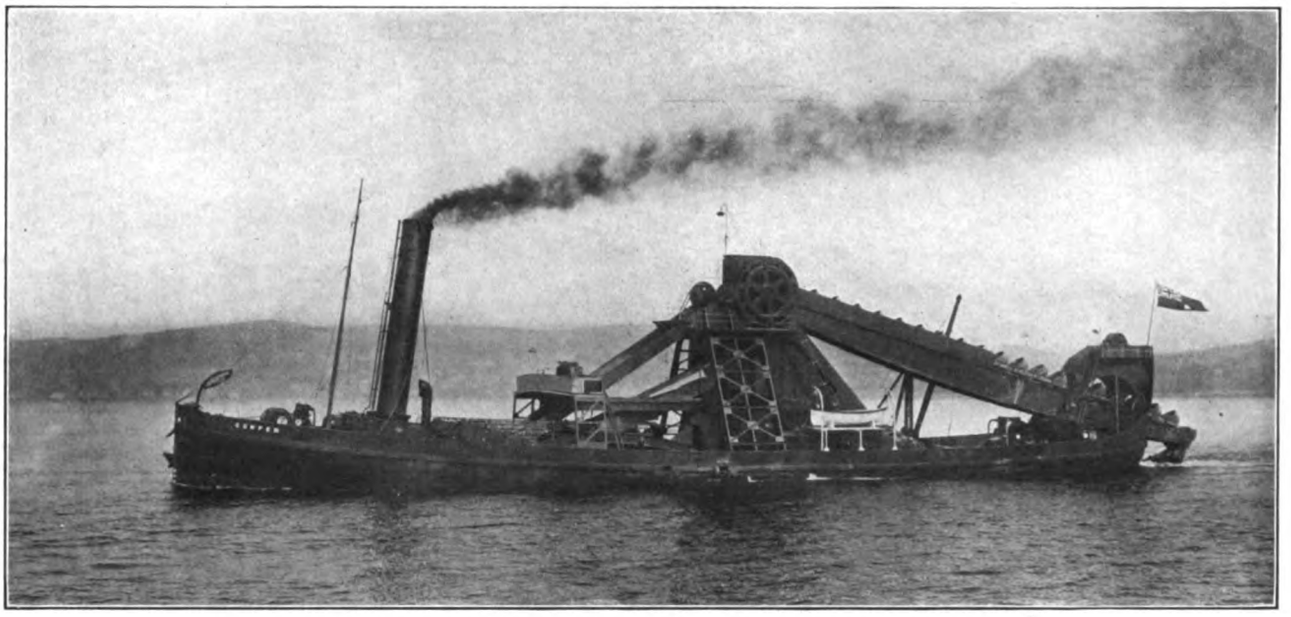

Fig. 1.—Twin-Screw Stern-Well Bucket, 1,000-Ton Hopper Dredger for Blyth Harbor

The three double-cylinder mooring winches are arranged one at the bow and two at the stern of the vessel. The hopper winches are situated at the forward end of the hopper, with separate double-cylinder engines. All the winches are constructed by the builders, and are of their well-known type for dredging purposes.

The hoisting gear for the bucket frame is of heavy construction throughout, the worm gear having been designed for continuous running under full load without overheating. The worm wheel is of phosphor bronze, the worm of forged steel. The main barrel is grooved to take the wire rope which leads to the blocks arranged on the after framing.

This dredger was built throughout by Messrs. Ferguson Brothers, Ltd., Port Glasgow, according to Lloyd's special survey and under the direction of Messrs. J. Watt Sanderson & Son, Newcastle-on-Tyne, the engineers to the Blyth Harbor Commission.

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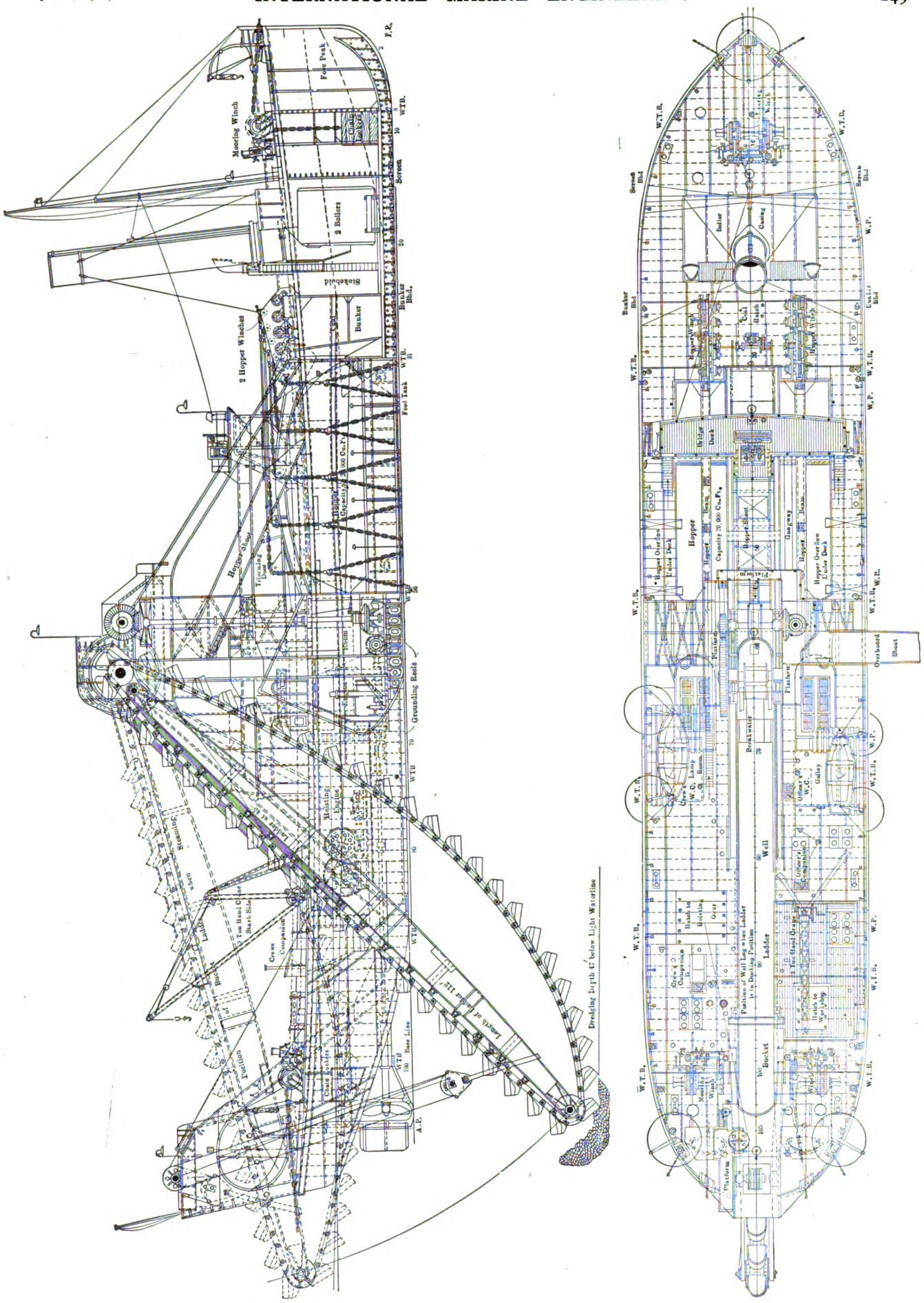


Fig. 2.—General Arrangement Plans of the Bucket Dredger *Cowpen*

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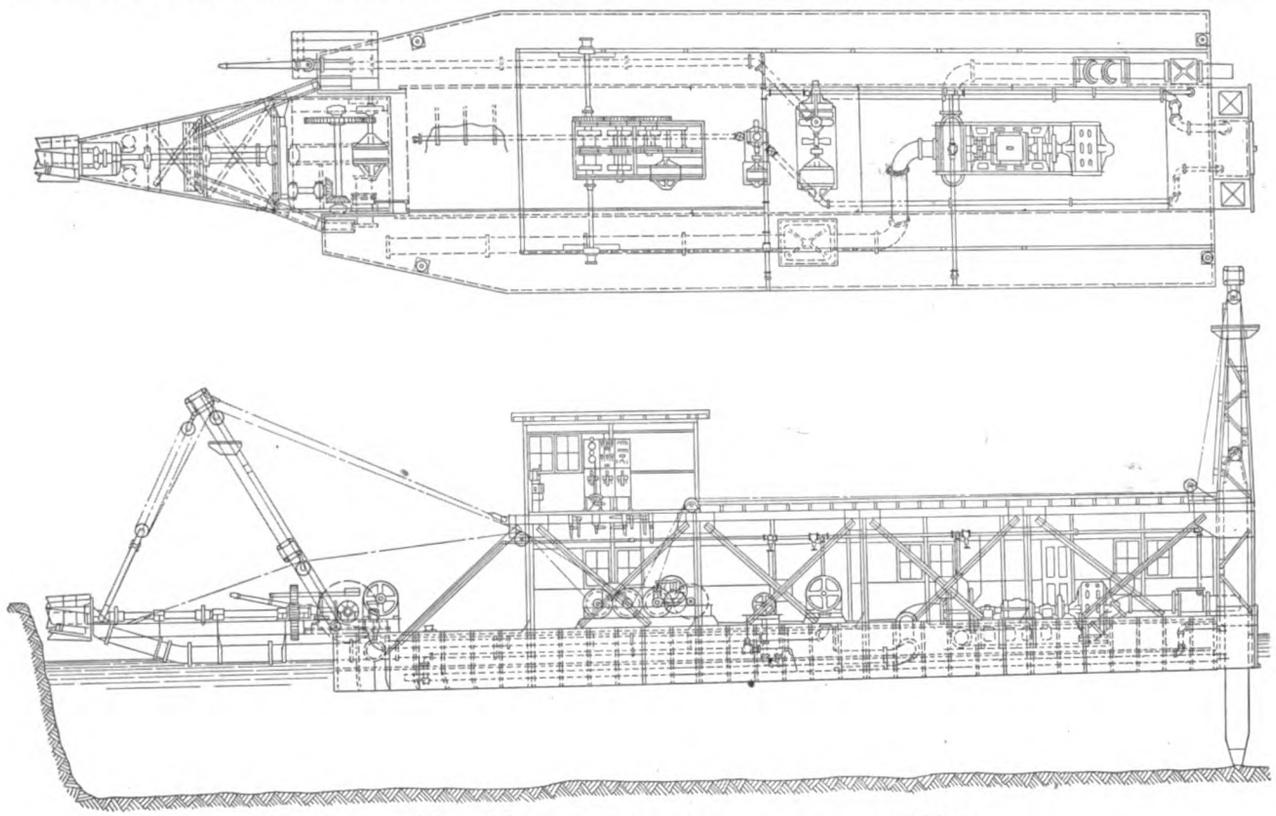
# A New Hydraulic Dredge for River Work in Cleveland

BY J. W. FELLMETH*

In order to reclaim 150 acres of valuable land in the suburbs of Cleveland, Ohio, it has been found necessary to change the course of the Cuyahoga River at a point where the river forms a horseshoe curve about 5 miles long. It is proposed to shorten this course by a straight channel approximately 2 miles long. Directly in the path of the new channel, however, is a hill which, together with the proper disposal of the excavated material, involves several quite difficult excavating problems.

The method finally decided upon involves the use of a hydraulic dredge operating in connection with a hydraulic giant mounted under the bow of the boat. The purpose of the giant is to wash down the hill so that the dredge can pick it up and deliver it to the old river channel through a pipe-line that will vary from 200 to 2,000 feet in length. The new channel will be approximately 200 feet wide at the waterline, 12 feet deep, and with a bank of from 30 to 40 feet at various places.



General Design of Special Hydraulic Dredge, Showing Arrangement of Machinery

The work of dredging will be done by P. T. McCourt, contractor, of Akron, and the special hydraulic dredge is now being built by The Marion Steam Shovel Company, Marion, Ohio. The dredge will be capable of delivering approximately 225 cubic yards of solid material per hour through a pipeline 2,000 feet long.

The illustration shows the general design of the dredge and the layout of the machinery. The dredge hull is built entirely of steel, and measures 80 feet long, 25 feet wide and 5 feet in depth. Two 4½-inch trusses are used for stiffness both fore and aft and for supporting the pilot house and the superstructure. The pilot house is situated so that the operator may at all times have an unobstructed view of the operation of the cutter, side lines, spuds and pipe-line. The control apparatus and all electrical appliances are placed in the pilot house, so that the operation of the dredge can be controlled by one man.

The machinery throughout is electrically driven by 2,200-volt, 3-phase, 60-cycle motors. The main dredge motor is of the variable speed type, of 300-horsepower capacity, with continuous rating and the necessary control for operating continuously at 25 percent speed reduction. This motor is direct connected to the main pump, which has 16-inch suction and discharge openings, and is mounted on a common bedplate. When operating at full load it will run at 345 revolutions per minute, at which speed the pump will deliver material at the rate of 12 feet per second through 2,000 feet of pipe.

A 6-inch, three-stage monitor pump is placed on the bow of the boat, and it will furnish water under pressure to the hydraulic giant for washing down the bank ahead of the dredge. This pump will be direct connected to a 200-horsepower constant-speed motor that will enable it to deliver to the nozzle 1,300 gallons of water per minute at an estimated pressure of 160 pounds per square inch.

The cutter used in breaking up the material ahead of the dredge is of heavy cast steel construction, connected to a structural steel frame mounted on the bow of the boat, and driven by a 75-horsepower variable speed motor direct connected by a train of gearing. This motor will operate continuously down to 50 percent speed reduction. The winding machinery is also placed near the bow of the boat, and is used in raising and lowering the spuds, in swinging the cutter ladder from one side of the cut to the other, and in raising and lowering the cutter. This machinery is driven by a 20-horsepower variable speed motor fitted with a solenoid brake, which will quickly bring it to rest when the current supply is broken. A general service pump is mounted alongside the monitor pump, and is used in pumping bilges, hosing off the deck and for fire protection. This pump is driven by a

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20-horsepower motor direct connected by a flexible coupling.

The whole channel must be completed during 1914, and as it will be necessary for the dredge to operate both day and night, a searchlight has been mounted on a pedestal near the monitor nozzle so that plenty of light may be had for night operation.

## 20-Inch Electric Dredge St. Louis

A dredge interesting on account of its many novel features, and on account of the severe conditions under which it is successfully working, is the 20-inch electric dredge built by the Morris Machine Works, of Baldwinsville, N. Y., for the Kinser Construction Company for their work at East St. Louis, Ill.

The dredge is built with a wooden hull and deck-house. The hull is 133 feet long on the deck, 35 feet wide and 9 feet deep. The deck-house is 84 feet long, 27 feet wide and 12 feet high. The draft, loaded, is practically 5 feet, and the gross tonnage 575 tons.

The dredging pump has a 20-inch suction and discharge, with the shell, disk liners and runner of manganese steel. The shell is designed to accommodate runners of various diameters, from 50 inches to 60 inches, to be used according to the length of pipe-line and the elevation against which the pump is working. The main motor is a 1,000-horsepower, type I, 8-pole, 2,200-volt, 375-revolution per minute synchronous speed motor, arranged with continuous-duty resisters for a 16 percent speed reduction below full-load speed.

The winding machine is a seven-drum hoist, driven through machine-cut steel gearing by a 75-horsepower motor operating at 500 revolutions per minute, with a gear ratio of 34.5 to 1. The construction of the winder hoist is of steel throughout, of extremely heavy proportions, designed for a duty of 18,000 pounds pull per wire at a speed of 100 feet per minute. The frictions and brakes on these drums are all operated by air pressure, with the control located in the lever house, situated on the roof of the deck house. This makes a remarkably compact arrangement and one calling for very little physical effort on the part of the operator. All drums are grooved to fit the rope for which they are used.

At the time the dredge was designed the contractor expected to encounter a good deal of stiff clay, so a ladder with the customary cutter was provided. The cutter was driven by a 75-horsepower, 500-revolution per minute motor, similar to the winder machine motor, geared through machine-cut steel gearing with a gear ratio of 40 to 1. The control of this motor, as well as the winder motor, was located in the lever house, each being provided with resistances to give a 75 percent reduction in speed, operated through a 14-point controller.

The ladder was extremely heavy, weighing 60 tons, all parts being of steel construction. It was designed to dig at a depth of 35 feet at an inclination of 30 degrees, or in case of extremely deep water to dig 55 feet at an inclination of 45 degrees. During the first four months the dredge was operated with the cutter, but as very little clay was encountered it was decided to take off the cutter and a suction mouthpiece was put in its place.

There are two 6-inch two-stage centrifugal pumps direct connected to a 35-horsepower, 1,500-revolution per minute motor, furnishing water to fire lines, service lines, to syphons for draining the bilges and for priming the dredging pump. Two 3-inch vertical bilge pumps, driven by a 10-horsepower motor at 750 revolutions per minute, are located on deck. To furnish air for winder frictions and brakes one 50-cubic feet per minute double-cylinder air compressor is provided, with one 75-cubic feet per minute double-cylinder air compressor. A 30-kilowatt, 2,200- to 115-volt, 3-phase transformer furnishes deck lighting service and power to the motor generator for a searchlight.

Two 30-inch Oregon fir spuds, fitted with cast iron points, weighing 8,500 pounds, are installed. The spud keepers are of cast steel, made in halves so that the spuds can be removed readily. The spud frame and ladder "A" frame are both of structural steel guyed by steel cables to the hogging trusses, which are built onto the steel trusses extending the full length of the boat.

Power to drive the dredging machinery is supplied by the East St. Louis & Suburban Railway Company. It is carried from the power house to the shore along which the dredge is working, a distance of 2 miles, at 13,200 volts. The voltage used on all the machines on the dredge is 2,200. The transformers are located on a barge anchored at the shore. Armored submarine cables connect the transformer to the shore line and to the dredge.

The dredge was designed to operate either with spuds and swinging wires from the end of the ladder or entirely by wires without the aid of spuds. With the dredge working to a depth not to exceed 50 feet the spuds were used, but when it was found necessary to go deeper than this to get sufficient material the use of spuds was abandoned and cables used alone. For several months this year the dredge has been raising the material from a depth of 74 feet below the water surface, which is believed to be a record for a hydraulic dredge. The material is discharged to a height of 45 feet above the zero stage of the river, through 1,000 feet of pontoon pipe and a shore line varying in length of from 1,000 to 2,000 feet more.

The total pay yardage to date handled by the dredge has been 2,825,000 in seventeen months, or an average of 166,000 yards per month, a very good average when the extreme depth of water and unusual height above water against which it had to be discharged are considered.

The running time of the dredge has been remarkably good; whatever delays having been experienced were mainly due to conditions outside of the dredge. All parts of the dredge were designed with the view of giving hard, continuous service, and at the same time permit of rapid work whenever a renewal became necessary. Overhead trolleys were installed over the heaviest pieces of machinery. An instance of the value of the above is shown when on an occasion it was desired to change runners in the main pump. The pump was dismantled, the old runner removed and a new one put in its place. From the time the dredge shut down to the time it was again pumping material out on the spoil bank was just two hours and thirty-five minutes.

## Safety First

The attention given at the present day by employers to safety devices for the protection of life and limb of employees in shops and factories has lessened the accidents due to carelessness on the part of employees as well as those due to no fault of their own. The unprotected emery wheels and grindstones in the shops in former days were a fruitful source of accident to the employee.

In the up-to-date shop of to-day all grinding wheels are enclosed in such a manner as to protect the employee from the flying parts should the wheel burst, and no longer do you see the projecting set screws securing pulleys to the shafting revolving around with the machinery in close proximity to the clothing of the workmen.

Some years ago the dungaree clothing of a workman in a machine shop, in the presence of the writer, became entangled with a projecting set screw on a shaft of a grindstone, and his clothing was wound round and round the shaft until he had nothing remaining but his shoes and socks. The set screw was then changed to prevent the recurrence of such an accident that might not always end so fortunately. J. E. C.

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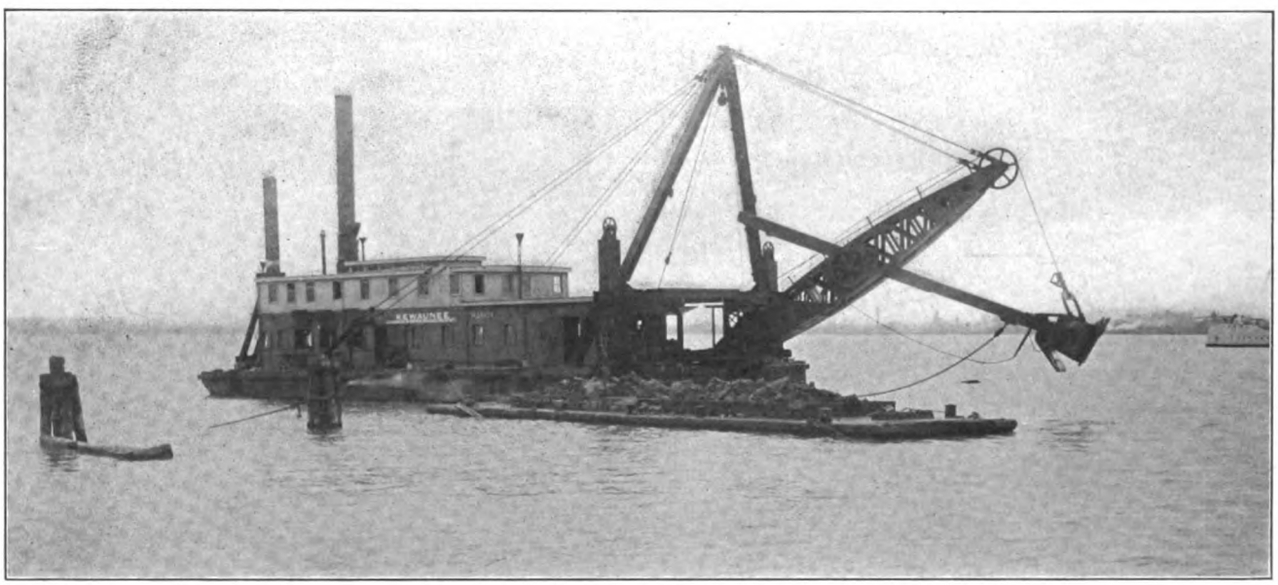
# 4-Cubic Yard Dipper Dredge Kewaunee

**A Government Dredge Designed for Digging to a Depth of 25 Feet with an Output of Over 200 Cubic Yards per Hour**

BY FRANK RENZENBERGER, M. E.*

The Marion Steam Shovel Company, of Marion, Ohio, has recently built for the United States Government the 4-cubic yard dipper dredge *Kewaunee* for use in the harbor at Kewaunee, Wis.

The dredge has a composite hull of the following general dimensions: Length, 100 feet; width, 34 feet; depth at bow, 9 feet 8 inches; depth at stern, 8 feet 8 inches; crown of main deck, 4 inches dead rise. The hull, built of open-hearth steel, is composed of transverse frames spaced 24-inch centers, with 6-inch channels for the bottom, deck and floor beams, and



Government Dipper Dredge *Kewaunee*

6-inch by 3½-inch side angles connected to the floor beams by suitable gusset plates. An inboard girder is fitted between the bottom and floor beams, extending from bow to stern, and composed of a vertical plate with 3½-inch by 3½-inch angles top and bottom clipped to the transverse beams. There is also an outboard truss girder, extending from bow to stern, and fitted between the bottom frames and the main deck. In connection with the truss girder the longitudinal coal bunker bulkhead is also fitted between the beams, extending forward from the stern to a transverse bulkhead, located forward of the boiler room. There is also a second transverse bulkhead located forward of the main machinery, thus dividing the hull into three compartments fore and aft. The hull planking is of fir; the bottom 4 inches thick, sides 5 inches, the bow, the aft end and slope 6 inches, and the deck 3½ inches thick. All plank is fastened to the steel work with galvanized bolts. The boiler room floor, together with the floor around the main machinery, is composed of steel checker plates.

The forward spuds are of fir, 26 inches by 26 inches, stiffened by corner angles extending full length. The spuds are housed in steel casings, built up of plates and corner angles, and secured to the hull by heavy plate brackets. The casings are provided with open-hearth steel hinge castings for unshipping the spuds.

The stern spud is of fir, 20 inches by 20 inches, and is stiffened by corner angles extending the full length. It is of the walking or trailing type, and is mounted in suitable guides on the stern of the dredge. All spuds are provided with open-hearth cast steel points.

### The A-Frame and Swinging Circle

The A-frame is built entirely of steel with cast steel head and foot castings, and is 44 feet high above the deck. The foot of the A-frame is pin-connected to a cast steel step casting, securely bolted to a beam across the top of the forward spud casings. The head casting is of open-hearth steel, firmly riveted to the A-frame legs, and provided with a hammered steel journal pin for the A-frame yoke. The yoke is a single open-hearth steel casting, bronze bushed, and to it the boom guys are attached. The back of the A-frame head casting is provided with two large lugs to which the back guys are secured.

The swinging circle is 18 feet 4 inches diameter, and revolves on a steel base casting 45 inches in diameter. The circle is built up of plates riveted to the hub casting, to which the foot of the boom is hinged, and to which the cross braces supporting the channel rim are secured. The front of the swinging circle is left open in order to provide sufficient clearance for the dipper handle when the dipper is pulled back. The swinging cables pass around a steel casting, and are connected by long adjusting bolts for taking up the stretch in the ropes. The base casting is provided with a lip extending down over the bow.

The boom is of the double-bow trussed type, 45 feet long between centers. It is built entirely of steel and is provided with an open-hearth cast steel point and foot casting. The shipper shaft is of hammered steel, on each end of which the brake wheels are mounted. These wheels are provided with check bands lined with wood blocks; the ends of each band being connected to a rock shaft, which is operated by a lever

* Chief Correspondence Engineer, The Marion Steam Shovel Company.

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at the foot of the boom. The manganese steel shipper pinions are mounted on this shaft, and engage the manganese steel rack on the dipper handle. The handle is held to the pinions by a yoke or saddle block, which consists of a cast steel reach block, to which is secured a steel frame carrying two sets of steel rollers, grooved to clear the rack bolts. The bearings in this block are provided with removable bronze bushes. The boom sheaves are 63 inches diameter, of open-hearth cast steel with machine turned grooves, and are bronze bushed and mounted on hammered steel shafts.

The dipper handle is 48 feet long, composed of two members, 7½-inch by 10½-inch fir timbers, armored with 7½-inch by 8-inch angles and bars, to which is secured the manganese steel rack. There is an open-hearth steel socket and adjusting casting. This is for pin-connection to the dipper so as to allow the pitch to be changed to suit the work.

### DIPPERS

Two dippers were furnished with this machine, one of 4 cubic yards and the other of 2 cubic yards capacity. The entire front of each dipper is composed of a single manganese steel casting extending from the top to the bottom of the dipper and well around the corners, where it is riveted to the side plates. The front is fitted with four short teeth or points of manganese steel—no bases being used. The sides of the dipper are composed of steel plates, connecting the manganese front with the open-hearth steel dipper back, which is provided with lugs, to which the dipper handle, pitch braces and dipper hinges are attached. All pin holes in the dipper subject to wear are provided with removable bushings. Both dippers are provided with double doors.

### ENGINES

The main engines are double, 14 inches bore by 16 inches stroke, of the horizontal stype and non-reversible. The bedplates are cast separate, and mounted on each side of a structural steel frame in line with the drum-shaft bearings. These engines are proportioned throughout for continuous heavy duty, and are fitted with a throttle of the balanced piston type with lowering control. The engine shaft is of hammered steel, and to it is keyed the cast steel engine pinion. The engines are compound-geared to the hoisting drum, which is provided with a differential barrel grooved for double ropes. This drum is mounted on a hammered steel shaft and is set directly ahead of the engines. The backing drum is mounted on a hammered steel shaft, and is placed forward of the hoisting drum to which it is geared, and both drums are actuated by frictions of the outside band type, set by steam. The cylinders for operating these frictions are attached to the spokes of the gears. All gears and pinions on the hoisting and backing machinery are of open-hearth cast steel with machine-cut teeth.

The swinging engines are double, 9 inches bore by 9 inches stroke, reversible by a central valve of the balanced piston type, and require but one operating lever. The engines are compound-geared to the swinging drum through a hammered steel intermediate shaft, set directly ahead of the engines. The swinging drum is grooved for rope and is keyed to a hammered steel shaft, the whole being mounted on a structural steel frame. All gears and pinions are of open-hearth cast steel with machine-cut teeth.

### SPUD MACHINERY

The forward spud machinery consists of two independent units, which are duplicates of the swinging machinery described above, with the exception that the intermediate shaft, in addition to the gears and pinions, is provided with a heavy brake for locking the spuds. This brake is lined with wood blocks, and is set by a powerful toggle lever so that the spuds can be locked in any position desired. The spuds are connected to the machinery by means of a double-hitch cable, and they are provided with sheaves on both the upper and lower ends, the cable passing around these sheaves and being connected to the castings on the spud casings, so that the spuds may be raised or the dredge pinned up as may be desired.

The aft spud machinery is mounted on a steel frame, and is provided with a double engine, 6 inches bore by 7 inches stroke, compound-geared to the spud drum through a hammered steel intermediate shaft. It is provided with a friction of the inside expanding type so that the drum can be disengaged for dropping the spud when desired. The outer rim of the friction housing is provided with a brake band for holding the spuds in any position desired—the connection to the spud being made by direct hitch.

The operating levers are banked in quadrants and placed so as to be within easy reach of the operator. They are placed well forward on the deck, so that the operator has a clear view of the work and practically the entire dredge under his control.

### BOILER

Steam for all main and auxiliary machinery is furnished by one dry-back Scotch marine boiler, 9 feet 8 inches diameter by 16 feet 3 inches long, built for a working pressure of 130 pounds. It has two 42-inch corrugated furnaces and 108 3½-inch tubes. The boiler is lagged with asbestos and magnesia, 2 inches thick, and is covered with canvas. The stack, which is 34½ inches in diameter, extends to a height of 48 feet above the grates. The boiler is supplied with a full equipment of boiler fittings, feed, fire and water service pumps, injector and feed-water heater.

There is installed on the dredge a 5-kilowatt, direct-current generator, direct connected to a high-pressure, non-condensing steam turbine—all mounted on one bedplate. The lighting system includes a complete switchboard, with all wiring, conduit, fixtures and lamps for properly lighting all parts of the dredge, and including two arc lamps forward for night work.

For handling scows two independent vertical capstans, operated by double non-reversing engines, are located on either side of the hull. A full equipment of deck fittings, such as bitts, chocks, cleats, etc., are conveniently located on the deck.

The deck-house, which is built of wood, completely encloses the machinery and boiler. It is well lighted by large windows. The upper deck is fitted up with nine staterooms with double built-in berths. In addition to these there is an office, galley, pantry and a mess hall, capable of seating twenty-two men at one time. The dredge is also provided with lavatories, closets and shower bath. Steam is furnished to the heating system from the main boiler through a reducing valve operating down to 25 pounds.

The dredge is designed for digging to a depth of 25 feet below the surface of the water, and should have an output of from 200 to 250 cubic yards per hour in ordinary fair material. The dredge was erected at Milwaukee, Wis., and after making a successful trial run was taken to its present location, Kewaunee, Wis.

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ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—The next annual meeting of the Society of Naval Architects and Marine Engineers will be held in New York on December 10 and 11, 1914.

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SUMMER MEETING OF THE INSTITUTION OF NAVAL ARCHITECTS.—The summer meeting of the Institution of Naval Architects will be held at Newcastle-on-Tyne, July 7 to July 10, at the invitation of the North-East Coast Institution of Engineers and Shipbuilders. In addition to the reading and discussion of papers arrangements will be made to visit some of the principal works in Newcastle and its vicinity.

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## American-Ball Four-Cylinder Triple-Expansion Dredge Engine

The dredge *Duwamish No.* 1 and two steel hull Government dredges, recently constructed on the Pacific Coast, are equipped with a new design of dredge engine, built by the American Engine & Electric Company, Bound Brook, N. J. The *Duwamish No.* 1 is in commission on the Duwamish Waterway, near Seattle, Wash., while the new all-steel Government dredges *Multnomah* and *Wahkiakum*, are operating on the Williamette and Columbia Rivers as far as Tongue Point, just above Astoria. These dredges, together with three older machines, will be able to deepen the channel in two years to a depth of 30 feet below low water.

The engine has a continuous capacity of 1,000 horsepower condensing, with an initial steam pressure of 250 pounds. The pump size is 24 inches, and the capacity is from 15,000 to 25,000 yards per day, depending on the material dredged. The length of the engine and pump is only 27 feet, and to the outside of the suction pipe 33 feet. The beam of the *Duwamish* is 40 feet, and of the two steel-hull dredges 38 feet. The length of the engine from the outside of the flywheel to the center of the coupling is only 14 feet. This length is practically the same as that of a vertical two-cylinder engine, whereas this engine has four cylinders—two vertical and two horizontal. If the four cylinders were vertical there would be five bearings instead of three, eight cranks instead of four, and the length would be correspondingly greater. The engine and pump would therefore have to be installed fore and aft.

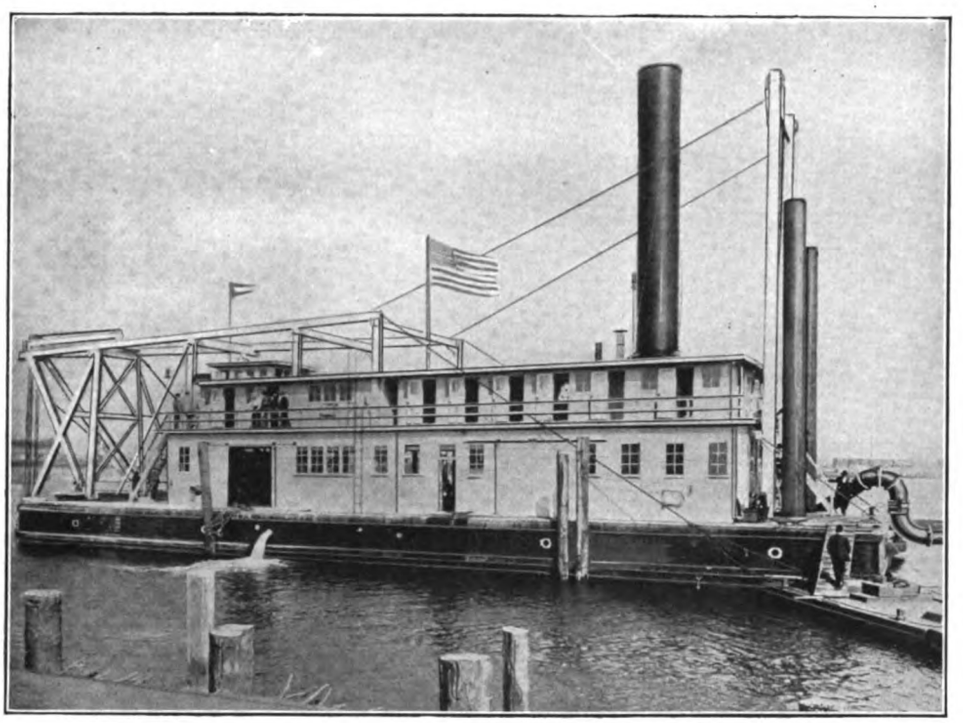

Fig. 1.—Dredge *Duwamish No.* 1

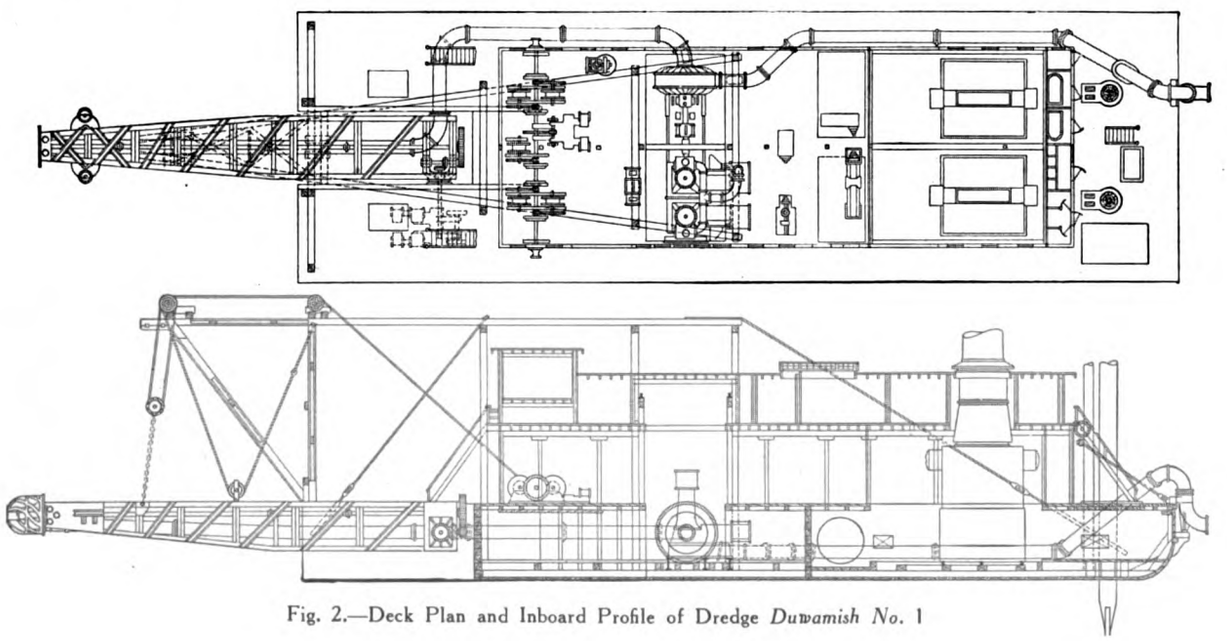

Fig. 2.—Deck Plan and Inboard Profile of Dredge *Duwamish No.* 1

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The arrangement shown in the drawings is exceedingly compact. The engine utilizes the entire beam of the dredge for only a short portion of its length, and leaves large spaces forward and aft of the engine for other machinery. The hydraulic piping is not brought through the center of the dredge, but is entirely at one side, and does not cause interference with other machinery or piping.

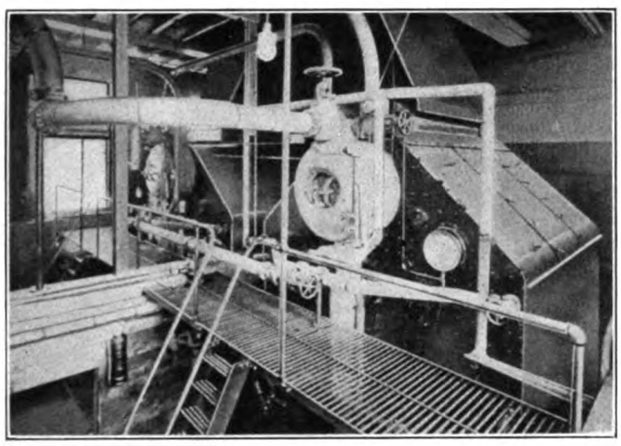

Fig. 3.—Boiler Room

The engine is of the angle type. In Fig. 6 the high-pressure cylinder, which receives steam at 250 pounds pressure, is shown in the foreground, the intermediate-pressure cylinder to the right of this, while the two low-pressure cylinders are vertical. This construction not only gives a large ratio of expansion, and therefore high economy, but eliminates an enormous low-pressure cylinder with its massive reciprocating parts. With a single low-pressure cylinder the speed would have to be materially reduced, and this in turn would increase the size, weight and space required by the engine. By reducing the expansion ratio and using a smaller low-pressure cylinder, higher speeds may be attained but economy is sacrificed. Thus the American-Ball four-cylinder triple-expansion engine shows an economy several pounds better than the three-cylinder vertical. Furthermore, with the four-cylinder angle construction the engine balance, it is claimed, is perfect, and higher speeds may be used, since the inertia forces of the horizontal reciprocating masses are opposed and balanced by equal and opposite forces from the vertical cylinders.

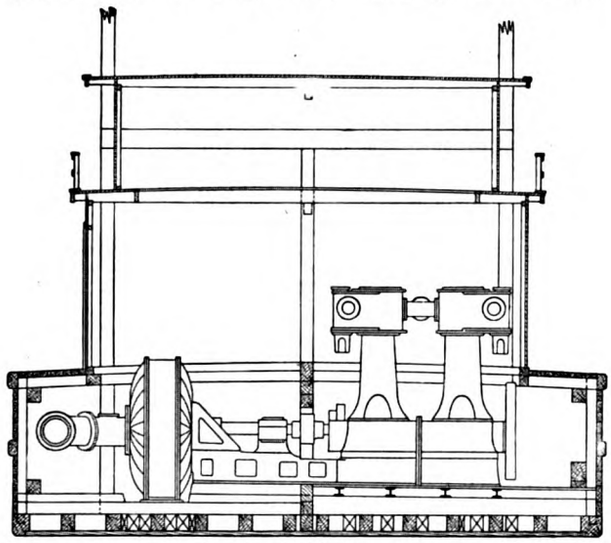

Fig. 4.—Midship Section

Owing to the freedom from vibration and pounding stresses the support for the engine is very simple, and consists, as may be seen in the drawings, of a simple cradle of I-beams. There is no special stiffening of the dredge, which, in the case of the *Duwamish*, is built entirely of wood.

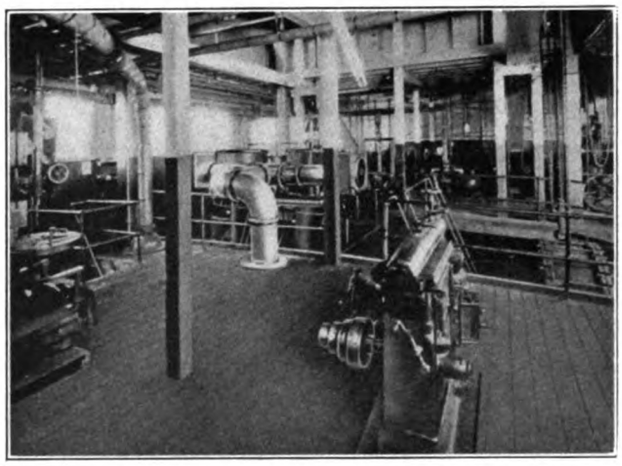

Fig. 5.—View on Main Deck in Machinery Space

The details of engine design are in general similar to standard American-Ball engines. Mention should be made of the oiling system. All parts are supplied with oil from two central storage tanks, which may be seen in Fig. 6 between the two vertical low-pressure cylinders. The oil collects by gravity, is filtered and then returned to the elevated tanks by two pumps operated by the valve gear rocker arms of the horizontal cylinders. One of these pumps with its plunger can be seen to the left in Fig. 6. The governor is of the standard American-Ball inertia type.

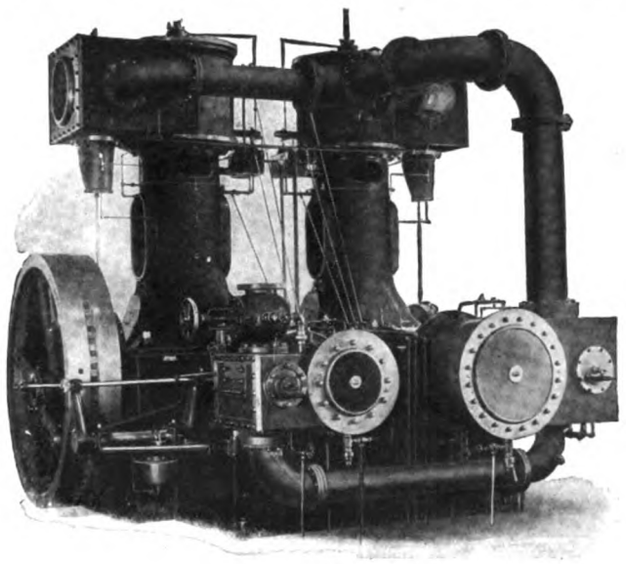

Fig. 6.—The Main Engine

The engine shaft is connected to the pump shaft by a jaw coupling. A heavy pedestal, shown in the cross section, carries two large pump shaft bearings. This construction takes strains off the engine shaft and gives ample stiffness to the pump shaft which carries the heavy overhung impeller as a cantilever.

The pump shown in Fig. 7 is of the Lockwood patent. The main feature in the construction of this pump, from the mechanical standpoint, is the ease of renewal of wearing surfaces; that is, the liners of the casing, especially the interior

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of the peripheral surface, against which the heavy solids are thrown by the impeller. The blades of the impeller, or runner, are held between two face plates, and alternate blades extend from the rim to the hub, the others extending about halfway. Short vanes are attached to the outer surfaces of the impeller to project sand and water from the clearance space between the impeller and casing, which would otherwise become clogged and cause serious wear of both the lining of the casing and of the runner itself.

The cutter head of the dredge is built of special hard steel, and is of the spiral knife type, built to work in any kind of

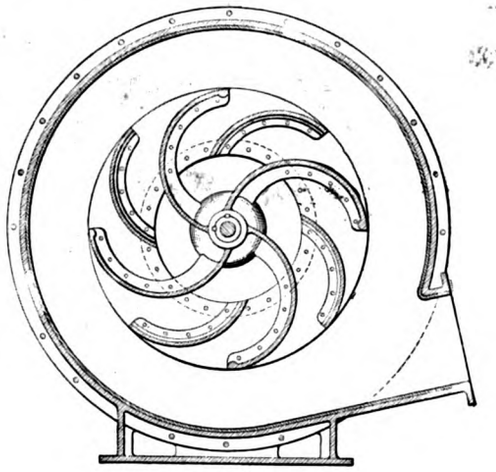

Fig. 7

material that can be loosened without blasting. It works in sand, cement, gravel, hard pan, or any refractory material short of solid rock.

The cutter engine, located in the bow of the dredge and opposite the piping, is a double-tandem compound engine of 250-horsepower capacity, driving the cutter through bevel gearing. The winding engines are simple, cross-connected double engines, and are located just behind the main winding gear shaft.

The dredge is fitted with a surface condenser built by the Seattle Construction & Dry Dock Company, and maintains a 25-inch vacuum. All auxiliaries exhaust into this condenser. A horizontal, direct-acting, combined pump handles both air and water.

The boiler equipment comprises two Ballin marine boilers, manufactured by the Ballin Boiler Company, Portland, Ore., having 7,000 square feet of surface, arranged for burning oil. Two large cylindrical oil tanks are located between the boilers and the main engine.

Besides the foregoing equipment there is an engine-driven generator, which supplies electric lighting throughout the dredge and arc lights on the forward deck for operation at night.

The *Duwamish,* and also the Government dredges *Multnomah* and *Wahkiakum,* are built from the designs of Mr. J. B. C. Lockwood, member American Society Civil Engineers, to whom we are indebted for drawings and photographs. The dredge *Duwamish* was guaranteed by its designer to have a capacity on its builder's trial run of 400 cubic yards per hour. This was largely exceeded, and during the test, which continued through 326 hours 30 minutes' actual running time, the average output was 714 cubic yards per hour. The dredge proves to have a capacity about double that of standard 20-inch machines working in similar material in the same vicinity, and proves beyond question that the 5 4/10 cents per cubic yard contract price for excavating 7,000,000 yards from the Duwamish Waterway is a profitable one.

## Priestman Grab Dredger

Early in 1913 Messrs. Priestman Bros. Ltd., Hull, built for the port of Antwerp Authorities the grab dredger *Watergeus No.* 3, illustrated on this page. The length of the vessel is 174 feet, the beam 28 feet 6 inches and the hopper capacity 800 tons. It is fitted with four 5-ton Priestman grab dredgers, the capacity of each grab being 70 cubic feet. The trials of this vessel took place at Antwerp between June 25 and July 19, 1913, with the following results:

Grab Dredger *Watergeus No.* 3

The coal consumption was about .125 pound per foot, and the economy was found to be 30 percent better than when dredging with bucket dredgers. The average output was 10,000 cubic feet per hour. In working 150 hours the four machines lifted 1,450,000 cubic feet of mud.

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## Twin Screw Sand Pump Hopper Dredger Leviathan

The most powerful dredger in the world is the twin-screw sand pump hopper dredger *Leviathan*, built by Messrs. Cammell Laird & Company, Ltd., of Birkenhead, for the Mersey Docks and Harbor Board. Her dimensions are: Length, 476 feet; breadth, 69 feet, and depth, molded, 30 feet 7 inches. The total deadweight carrying capacity is about 11,000 tons on 23 feet draft. The propelling machinery is placed aft, and consists of two sets of triple-expansion engines. Steam is supplied by four large single-ended boilers and the vessel's speed is 10 knots when fully loaded.

Immediately forward of the boiler room are the pumping engine rooms, which contain four sets of triple-expansion engines, coupled direct to four centrifugal pumps capable of pumping a full cargo of 10,000 tons of sand from a depth of 70 feet below the waterline in fifty minutes.

There are twelve hoppers, having a total cubic capacity of 180,000 cubic feet, arranged forward of the pump room. Along the top of the hoppers and extending for their entire length are two landers with two valves to each hopper worked by hand gear, so that any of these valves may be closed or opened, and thus regulate the trim of the vessel when pumping. The discharging of the spoil from the hoppers is carried out by Lyster hydraulic discharge valves. These valves are large, hollow cylinders fitted in the center of each hopper, covering circular openings 5 feet 6 inches diameter in the bottom of the hoppers. When discharging, the valves are raised 4 feet by hydraulic power worked from the fore-and-aft bridges by hand levers, and the spoil in the hoppers rushes out through the openings at the bottom. When dredging, the surface water is disposed of by flowing over weir plates, which can be adjusted to suit the trim of the vessel and thence overboard through large regulating trunks passing through the sides of the ship, two at each side, the sand settling to the bottom of the hoppers. When the vessel is fully loaded and the pumps are stopped, any remaining surface water is drained off by surface valves on the top of the Lyster discharge valves.

The dredging apparatus consists of four suction pipes connected to the pumps through the ship's sides. The pumps have sluice valves which can be shut off when the pumps are not in operation, the pipes are then hoisted upon the deck by four powerful winches. The suction pipes slide up or down on frames fixed on the ship's sides, and eight large jibs are used for hoisting, one at each end of the pipe. When the pipes are hoisted up to the deck there are deck slides, worked by a worm gear, which carry them inboard. In addition to the pipe hoisting winches there are four large steam winches for warping purposes, and also for use in case of emergency if the pipe-hoisting winches break down.

The vessel is equipped with powerful double steam winches, hand and steam steering gear, electric lights, etc. Comfortable accommodations are fitted up for the officers and engineers in the poop and for the crew in the forecastle, while a house for the dredging masters is provided on the navigating bridge.

Sand Dredge *Leviathan*

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TESTIMONIAL TO SYDNEY F. WALKER.—At the annual meeting of the South Wales branch of the Association of Mining Electrical Engineers last month, Mr. Sydney F. Walker, well known as a frequent contributor to these columns, was presented with a testimonial in the shape of a handsome gold watch as a token of esteem and respect, in connection with his presidency of the South Wales branch of the Association for the four first years of its existence. The watch bears an engraving to the above effect and was presented by the president of the branch, Mr. Godfrey Williams, of Aber Pergwm, a large colliery owner in Glamorganshire.

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CAPE COD CANAL.—According to an official announcement the Cape Cod Canal joining Cape Cod Bay to Buzzard's Bay will be open for general business in November, 1914. The toll rates for the use of the canal will average 10 cents (0s. 5d.) a ton per round trip.

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# The Westinghouse Marine Steam Turbine

**The First of a Series of Articles Describing the Latest System of Turbine Propulsion as Developed by the Westinghouse Machine Company**

The advances made by the Westinghouse Machine Company, East Pittsburg, Pa., in the development of the combination impulse and reaction turbine in connection with the Westinghouse floating frame reduction gear point towards a much wider application of the steam turbine to the propulsion of ships than has heretofore been possible.

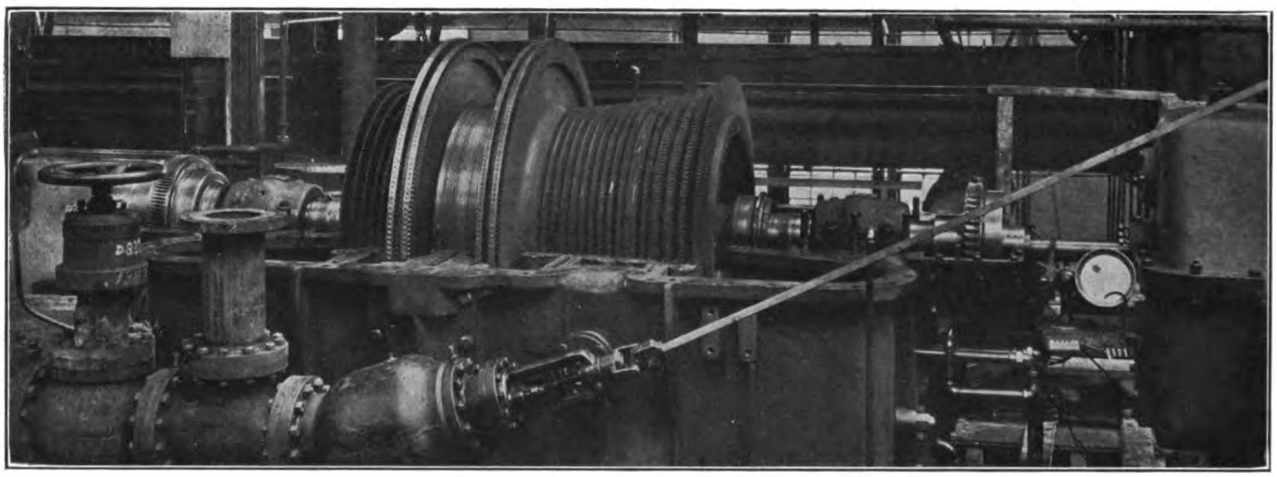

Fig. 1.—General View of Westinghouse Combination Impulse-Reaction Marine Turbine on the Test Stand, Showing Blading

The principal advantages of the reduction gear are generally well known. In the first place, the use of gears permits the turbine to run at almost any desired number of revolutions, and this materially reduces the size and weight of the turbine for any given capacity. At the same time the lower speed of the propeller enables the use of a larger and more efficient propeller, insuring a more economic means of propulsion in ships of comparatively slow speed. Furthermore,

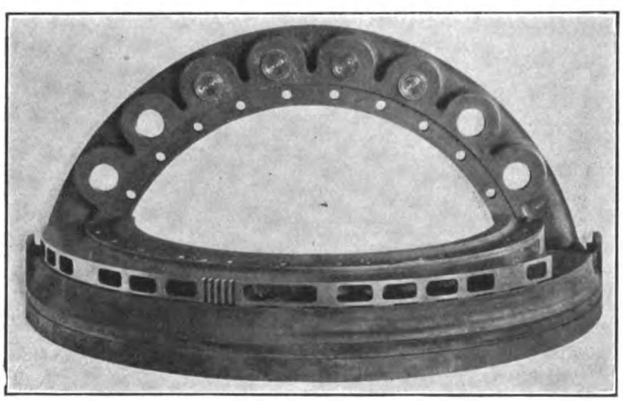

Fig. 2.—Nozzle Block and Sliding Valve, Partly Assembled

with the direct-connected turbine, owing to the increase in weight, and particularly the length of the turbine, it has been difficult to obtain a sufficiently large proportion of the ahead power in the astern turbine, and consequently the maneuvering qualities of the direct turbine-driven ship have not been all that could be desired. With the gear installation, however, owing to the lower speed, the propeller can be made of such ample area that its efficiency when reversing is very much higher than that of a direct-connected one. As a result of this higher propeller efficiency in the geared unit, a smaller proportion of the ahead power gives far better maneuvering qualities than a larger proportion of the ahead power gives in a direct installation.

With the increased speed of the geared turbine its economy is much higher than that of the direct-connected unit. In a geared turbine installation it is not necessary to develop more than 40 to 45 percent of full power ahead when running astern, since the starting and stopping torque available for bringing the turbine to rest reaches a maximum value of from three to four times the ahead full-power torque. In other words, a turbine capable of developing 40 percent full power ahead actually has a starting and stopping torque greater than the full-load torque ahead.

Most of the disadvantages encountered in a complete reaction turbine are obviated in the design adopted of the Westinghouse Machine Company by the substitution of an impulse wheel for the high-pressure motion of both ahead

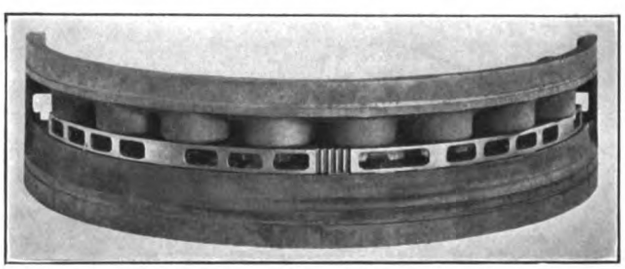

Fig. 3.—Ahead Nozzle Block, Sliding Valve and Balance Pistons Completely Assembled

and astern turbines. The use of the high-pressure impulse wheel instead of reaction blading in marine turbines has two important purposes: First, it has a greater stopping torque, and, second, it permits the use of nozzle control. The use of the impulse wheel, furthermore, materially shortens the ahead and astern turbines, thus making a more compact and lighter installation, and at the same time eliminating the short high-pressure reaction blades so that only a comparatively few rows of large substantial blades are required.

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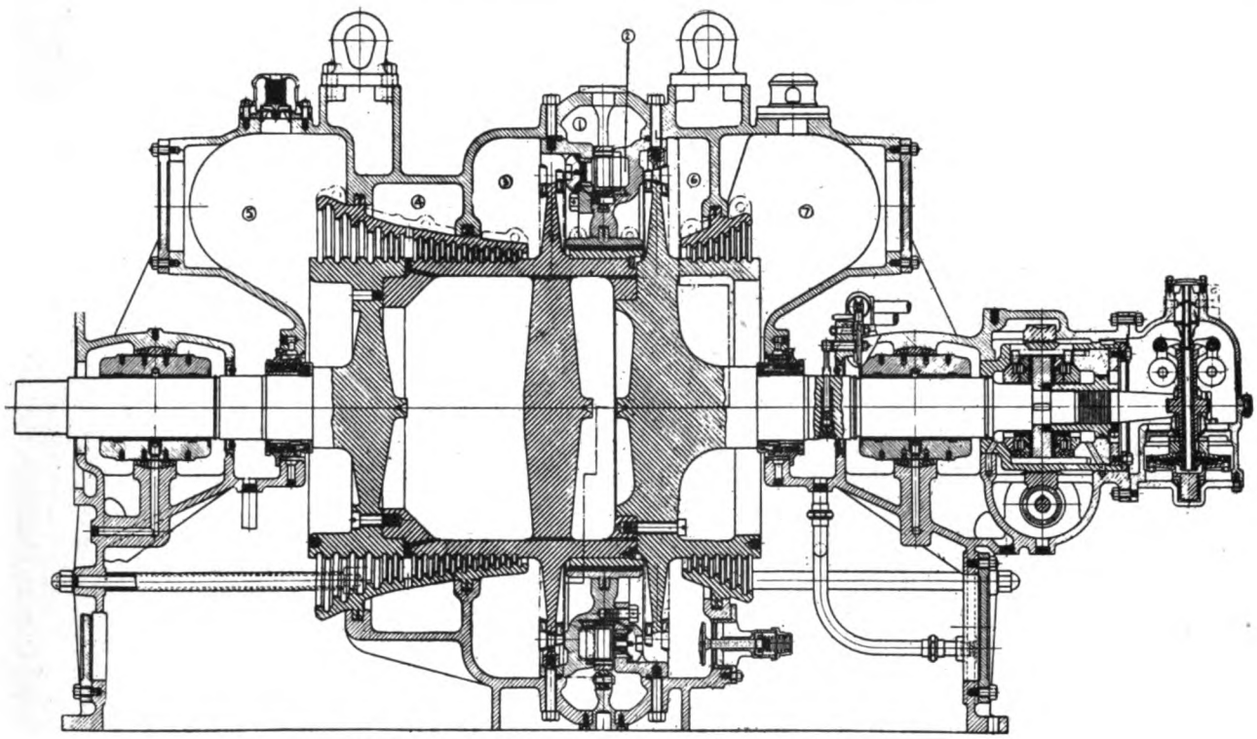

Fig. 4.—Sectional Elevation of Completely Assembled Turbine

The use of the combination impulse-reaction turbine has the further advantage that complete ahead and astern turbines of high economy can be contained in a common cylinder, thus obviating, except under some unusual condition, the necessity of employing the cross-compound arrangement of turbines. Each turbine, where two or more turbines are used to drive a common gear or independent gears, is a complete unit in itself, and may be operated independently of other turbines. In twin or triple-screw vessels each engine room is thus complete in itself without any cross connections and the attending application required to permit operating either high or low-pressure turbines when either one or the other is out of commission.

The combination turbine also has a decided advantage over the pure reaction or pure impulse type of turbine, since it obviates the short, frail blades of the high-pressure section of the pure reaction turbine and also obviates the troublesome diaphragm packings of the pure impulse turbine. Although the impulse wheel is not as efficient as reaction blading, it is nevertheless possible to so design the impulse wheels with two rows of blades that its efficiency will not fall off seriously when the steam velocity is only two and two and

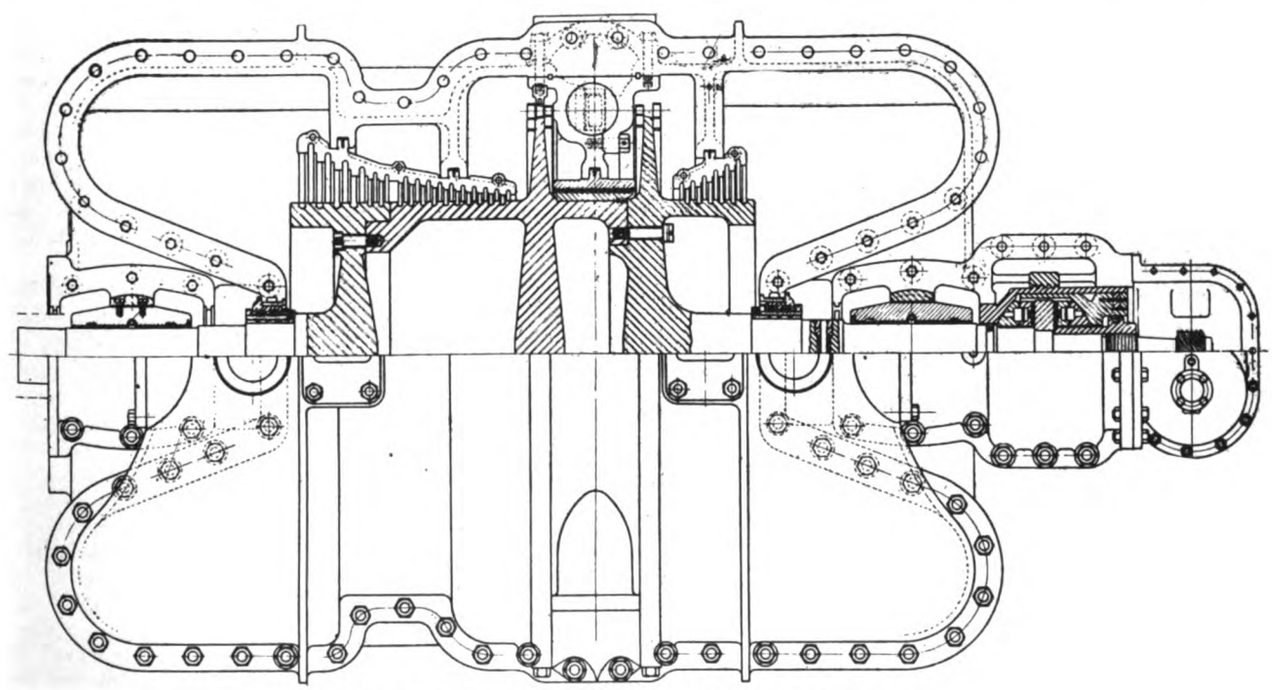

Fig. 5.—Semi-Plan and Longitudinal Section of the Turbine

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one-half times the blade speed, and will remain nearly constant until the velocity of the steam reaches four to four and one-half times the blade speed. Thus, by the use of nozzle control, the efficiency of the high-pressure portion of the turbine can be kept nearly constant for a considerable range of power and speed. With the impulse wheel blade space possible in a Westinghouse geared installation, such a large range of heat drop can be efficiently employed that economies only

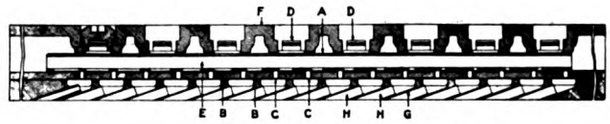


Fig. 6.—Nozzle Valve and Balancing Pistons

approached at full power in the past are possible at cruising speed, and special cruising turbines are entirely unnecessary.

While the following illustrations and description deal only with the Westinghouse marine turbine, subsequent articles will deal directly with the reduction gear, the system of bridge control developed by the Westinghouse Company, and the condensers and auxiliaries which form a part of the complete marine installation.

Fig. 6 is a cross section on the center line of the ahead high-pressure nozzles, showing the nozzle valve and balancing pistons, and Fig. 7 is a partial longitudinal section through

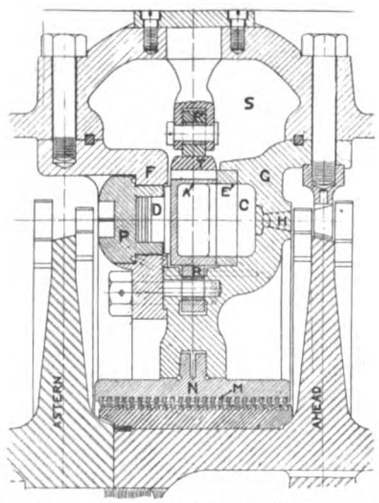


Fig. 7.—Section Through Nozzle Valve and Nozzle

the turbine showing the nozzle valve and nozzles. The valve *A* is made of Monel metal, the valve seat *E* of cast iron, and the balancing pistons *D* and retaining caps *P* are all made of bronze. The nozzle valve proper, *A*, is moved by a rack which engages with gear teeth cut in the periphery *T* of the valve, by means of which it can be partially rotated. To permit the movement of the valve with the least possible force, the valve is supported upon internal and external rollers *R* and *R'*.

The pressure of the steam on the valves is balanced by means of the small pistons *D*, of which there is one for each pair of nozzles, there being twelve nozzles in the ahead and sixteen nozzles in the astern. The space between the balancing pistons *D* and the retaining plugs *P* is connected to the space *C* of the second nozzle in each group of two; thus at any instant the unbalanced steam pressure can be equal only to the area of one of the ports in the valve *E*, admitting steam to the space *C*.

As will be readily seen from the developed cross section of the nozzle valves, the ports *B B* in the valve *A*, and the ports in the valve seat *E*, are so arranged that as the valve is moved to the left, the ports in *E* communicating with the nozzles are opened in succession, thus maintaining the full boiler pressure at the entrance to the nozzles, whether one or all of the nozzles are open.

In order to avoid leakage and distortion, the nozzle valve *A* is of rectangular section, cored out as shown in the developed section, Fig. 6, thus permitting the valve face to make

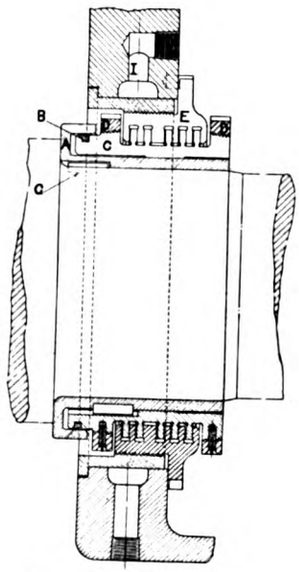


Fig. 8.—Turbine Gland

a steam-tight joint at each port which is not open, while at the same time the box construction ensures the circumferential rigidity necessary.

The main steam supply for the ahead opens into the space *S*, Fig. 7, in the lower half of the turbine cylinder, and steam for the astern opens into a similar space in the upper half of the turbine cylinder. Leakage from the space *S* into the turbine cylinder is prevented by dowel rings as shown.

As will appear later, there is but one dummy in the turbine which divides the high-pressure ahead from the astern turbine. This is shown in detail in Fig. 7. The dummy cylinder ring is a separate casting, which is supported from the nozzle ring *G*. The dummy strips are of the standard type employed in all Westinghouse turbines, and are twenty-four in number.

Fig. 2 shows one of the ahead nozzle blocks and sliding valve partly assembled, and also four of the balance pistons in place. Fig. 3 shows an ahead nozzle block, slide valve and balance pistons completely assembled ready to put in the turbine casing.

A cross sectional elevation of the completely assembled turbine is shown in Fig. 4. It will be noted that the turbine spindle is made in three parts, these being steel castings, one of which forms the forward spindle end and astern impulse wheel and reaction drum. The middle section of the spindle forms the ahead impulse wheel and part of the ahead reaction drum, the remaining part of the reaction drum and after spindle end being formed in a separate piece. The various parts of the spindle are bolted together. This spindle construction is unusually rugged and heavy for marine work, but it is partly necessitated by the comparatively high blade speed of the impulse wheels, which is 525 feet a second at full power. As the effective mean diameter of the ahead and astern reaction sections of the turbine are the same, a single dummy located between the two impulse wheels served for both the ahead and astern reaction sections. However, any slight unbalanced end thrust which may arise in either the

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fore or aft direction is amply taken up by a Kingsbury thrust bearing, which is clearly shown in the longitudinal cross section. It will be recalled that the Kingsbury thrust bearing consists of a number of independent babbitted shoes, each supported on a spherical seat formed in a ring, which itself is spherically seated in the bearing housing, thus permitting each shoe to adjust itself independently so as to obtain a uniform bearing pressure over its entire surface, and the spherical seating of the shoe-supporting ring permits the individual shoes to distribute the load equally among each other. A single collar on the shaft thus serves in place of the numerous collars used in the older type of thrust adjusting bearing.

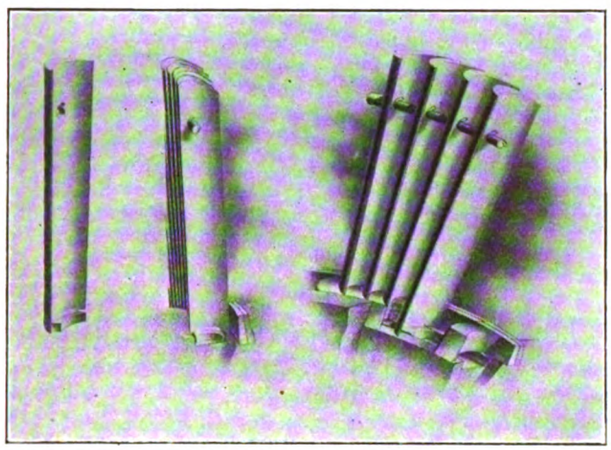

Fig. 9.—Construction of Blading

The turbine bearings are of the standard Westinghouse spherical seated type, with loose keys and shims, permitting centering the turbine spindle without the necessity of rebabbitting and boring the bearings exactly concentric with the bearing housing.

The turbine glands are a modified type of labyrinth packing, as shown in Fig. 8, consisting of a brass sleeve *A* on the shaft, in which a snap ring *B* fits and packs the sleeve *C*. The sleeve *C*, which is made in halves, is held together by the rings *DD*, which are screwed on tapered threads. The sleeve *C* fits snugly, but not tight, on the sleeve *A* and rotates with the shaft, but end movement of the sleeve *C*, relative to the shaft, is permitted so that the collars of the sleeve *C*, which fit in the bushing *E* with a few thousandths clearance, will not bind or press too heavily against the bush *E* when the spindle moves endwise from expansion or in taking up the slight end motion of the spindle in the thrust adjustment bearing. A feather key *G*, partly recessed in the sleeve *A* and partly in sleeve *C*, drives the latter with the turbine shaft.

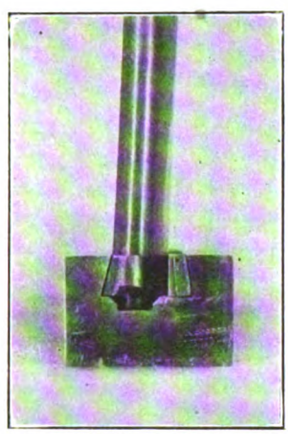

Fig. 10.—Method of Attaching Blade

The bushing *E* is screwed into a second bushing, as shown, thus permitting the whole stuffing-box to be removed from the turbine without removing the turbine cover. Steam for sealing and lubricating the labyrinth is supplied through the inlet *I*.

The stationary reaction blades instead of being held in the turbine cylinder proper, as is customary in marine turbines, are held in loose cast steel rings, which are doweled in the turbine cylinder so that they can be easily removed. This obviously permits the carrying of spare rings, bladed ready for use, thus facilitating rapid repairs in the event of damage to either the ahead or astern reaction blading. Fig. 1 shows the upper half of the reaction cylinder blade rings removed, exposing the spindle to view.

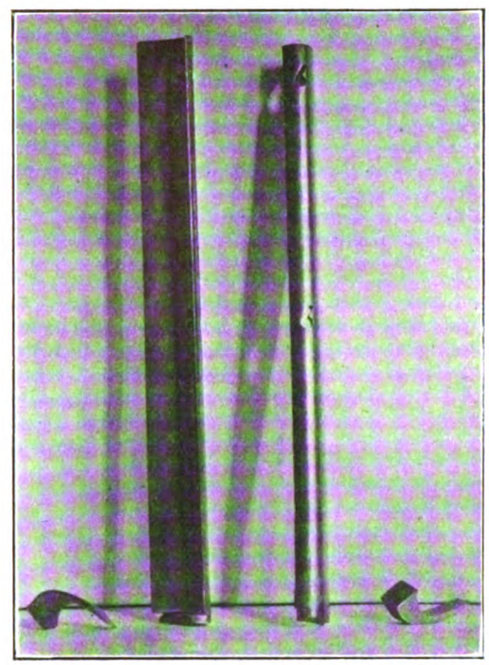

Fig. 11.—Showing Thickening of Ends of Blades

The auxiliary steam inlet to the ahead reaction blading connects into the space 4, Fig. 4, and through the holes shown in the reaction cylinder blade rings to the low-pressure ahead blading. The pressure at the point of admission of the auxiliary exhaust is about 16 pounds absolute at full power.

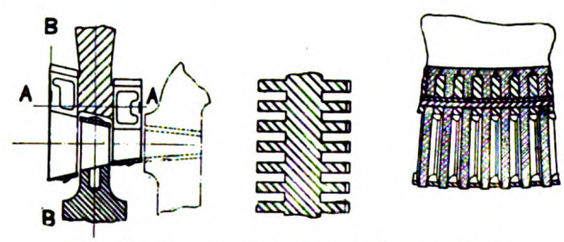


Fig. 12.—Method of Holding the Impulse Blades

The valve shown, connecting the astern impulse wheel chamber with the condenser, is provided to permit the escape of any steam leaking past the dummy when running ahead without the necessity of its passing through the astern reaction blading, and thus causing additional lost work. This is one of the decided advantages of the impulse wheel when used in this manner, as the steam leaking by the dummy cannot cause any additional resistance in the astern impulse

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wheel when the turbine is running ahead. By-passing the reaction blading obviates any loss at this point. This by-passing valve is operated automatically by a piston resisted by the spring, which normally holds the valve in an open position, as shown, but as soon as steam is admitted to the first astern nozzle, the pressure back of the piston brings the valve to its seat.

An automatic stop of the usual type fitted on all Westinghouse turbines, is provided. The automatic stop plunger in the spindle trips a valve which releases the steam pressure under the piston of the automatic stop valve in the main steam line, the automatic stop valve being placed ahead of the control valve so that it serves for both ahead and astern operation.

Fig. 5 is semi-plan view and longitudinal section of the turbine.

Fig. 12 shows the method employed to hold the impulse blades. As will be seen from the illustration, slots are cut in the narrow rim on each side of the impulse disk, and T-headed shanks on the blades are fitted in these slots, the blades thus being literally hung on a cantilever projecting from the impulse wheel disk. A groove is turned in each side of the projecting cantilevers, in which calking pieces are inserted, one of these being dovetail and the other flat. The purpose of these is solely to hold the blades from moving sidewise in the slots. This construction permits making the blade attachment as strong as the cross section of the blade itself, and at the same time reduces the weight of the rim supporting the blades to a minimum and simplifies the distribution of stresses at the rim materially. There is no change from hoop stress to disk stress, as the slots eliminate the tangential stress ordinarily existing in the rim.

In the past few years an entirely new method of blade attachment has been developed by the Westinghouse Machine Company, in which all dependence upon the frictional grip on the blades is eliminated. This new blade attachment is illustrated in Figs. 9, 10 and 11. Fig. 10 is a cross section of a model, which shows the undercut groove and a second smaller groove at the bottom of the primary groove, in which the upset ends of the blades fit.

As will be noted in Fig. 11, the ends of the blades are thickened by upsetting on a gradual taper extending from 1 to 3 or 4 inches from the root of the blade, the actual section of the blade being increased about 50 percent at the root, and at the same time a lip is formed which hooks under the dovetailed shape packing pieces shown. In the smaller blade sections the packing pieces are slipped in by turning them sidewise in the groove until all the blades have been inserted except one or two where the undercut in the turbine cylinder blade ring or spindle is removed to permit inserting the last one or two packing pieces, the space cut out of the dovetail for this purpose being finally filled with a soft calking piece.

In the case of the very largest blades where it is undesirable to remove part of the undercut of the spindle groove, the blades are held in place with double wedges, as shown in Fig. 9. The same form of comma lashing wire, which has been so successfully employed by the Westinghouse Machine Company, has been retained in marine turbines.

The upsetting of the ends of the blades and tapering of the normal section towards the tip of the blades, very materially increases the resistance of the blades to bending stresses, and also to those very serious stresses arising from vibration, and whereas in all other forms of reaction blading attachments the weakest section of the blade is where it meets the cylinder or spindle, this is the strongest point of the blade in the Westinghouse design. This is very clearly shown by the fact that when the lip, Fig. 11, is gripped in a vise and the end of the blade subjected to a bending pressure, the first indication of any bending whatever occurs some 2 to 3 inches from the lip in long blades, and, of course, at a somewhat shorter distance from the lip in very small blades. The result of this method of blading is that even most serious rubs between the blades and stationary portion may be encountered without any damage to the blades other than burring of the ends.

In order to permit the gear pinion to float longitudinally without imposing any end thrust on the teeth of the pinion or gear, a special flexible coupling was designed by Mr. Westinghouse. The coupling consists simply of two flanged collars, one on the turbine and one on the pinion drive shaft, and a ring bolted to the portion of the coupling on the turbine shaft. There is a slight clearance between the ring and the hub, and the driving force is transmitted through the ring to the hub by means of steel balls, which are inserted in holes drilled partly in the ring and partly in the hub. These holes are lined with hardened steel bushings made in halves, and the balls are retained from coming out of the hole by means of a retaining ring. This coupling is extremely simple and facilitates taking the turbine spindle or pinion out without disturbing any other part. After extended service it has proven itself entirely satisfactory for this work.

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## The New Hamburg-American Liner Vaterland

The *Vaterland*, of the Hamburg-American Line, which arrived in New York May 21 on her maiden voyage, is the largest steamship in the world. While closely resembling her famous sister ship, the *Imperator*, in construction and equipment, the *Vaterland* is of greater dimensions and presents many original features. The vessel measures 927½ feet in length over all, 100 feet in beam and has a gross tonnage of 53,500. On her trial trip the *Vaterland* is reported to have developed a speed of 26.3 knots.

The construction of the *Vaterland* was commenced in September, 1911, in the yards of Blohm & Voss, at Hamburg, and the vessel was launched April 3, 1913. She conforms in every detail of her construction and equipment to the latest rulings of the German, English and American laws governing shipbuilding. She is constructed with a double bottom and a double skin extending well above the waterline. Her hull is divided by steel bulkheads, both longtudinal and transverse, and contains five steel decks, which with four superimposed decks gives her nine decks above the waterline. Increased stability is obtained by the installation of Frahm anti-rolling tanks.

An entirely new arrangement of the public rooms has been made possible by the unusual position of the funnels of the *Vaterland*. The funnels pass through the decks at a point near the sides of the hull instead of through the center of the ship. By removing this obstruction it has been possible to have one great saloon open directly into another, thus giving the ship a remarkable effect of artistic spaciousness. This vista extends from the Ritz-Carlton restaurant through the winter or palm garden and the grand hallways, to the main lounge or ball room. The grand staircase, which is one of the most attractive features of the *Vaterland*, extends through six decks. The several staircases are supplemented by three passenger elevators in the first, and one in the second cabin, running through six decks.

The *Vaterland* is manned by a crew of 1,234 men. She is commanded by a commodore, four captains and seven officers. There is a chief engineer, three first engineers and thirty-five assistants and electricians. The boilers are operated by twelve chief firemen, fifteen oilers, 187 stokers and 189 trimmers.

In no other ship probably is electricity so generally employed. About 15,000 electric lights are installed, and the elevators, both passenger and freight, the hoists, derrick operating machinery, the kitchens, are all operated electrically. The cabins and staterooms of the first cabin are heated by

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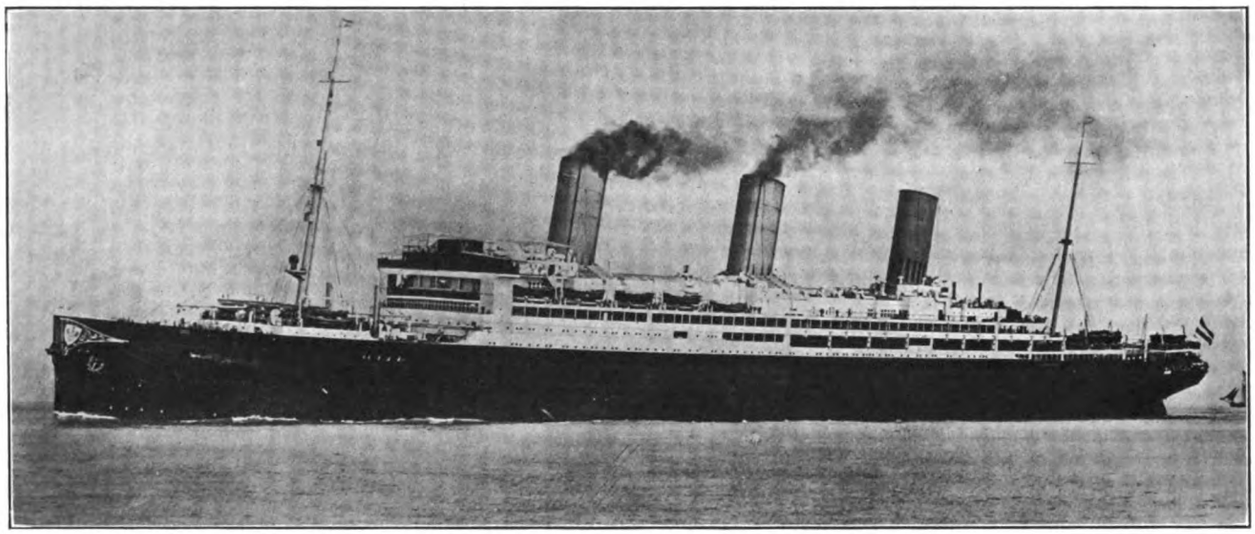

Fig. 1.—The Hamburg-American Liner *Vaterland* of Over 53,000 Gross Tons

electricity, and an abundance of fresh air is forced to every part of the ship by an electric ventilating system.

The main lounge of the *Vaterland,* the largest and most sumptuous of the public rooms, is provided with a concert stage and a dancing floor. The smoking room, located forward, directly beneath the bridge, is open on three sides, thus affording an uninterrupted view of the sea and assuring perfect light and ventilation. The main dining room seats upwards of 800 guests. The Ritz-Carlton restaurant is oval in form, exactly reproducing the restaurant under the same management in New York. A special feature has been made of the palm garden, which is decorated with a wealth of tropical foliage. The ladies' writing rooms, library and lounges are especially large and attractive.

The sumptuous Roman bath, which has proved such a popular feature on the *Imperator,* has its counterpart on the *Vaterland.* The swimming pool measures 20 by 40 feet, and has a depth of 10 feet, and grouped about the pool are a variety of therapeutic baths.

Propulsion is by four great screws, each 19 feet 7 inches diameter, driven by turbine engines. At full speed the propellers turn at about 150 revolutions per minute. Two high-pressure and two low-pressure astern turbines are provided. Steam is supplied by forty-six watertube boilers, arranged with four stokeholds. As a special precaution the forward engine room is divided into three watertight compartments, and the aft room into two compartments.

The *Vaterland* has accommodations for over 4,000 passengers. Her lifeboat equipment includes eighty-three lifeboats accommodating about 5,300 persons. Two of these are

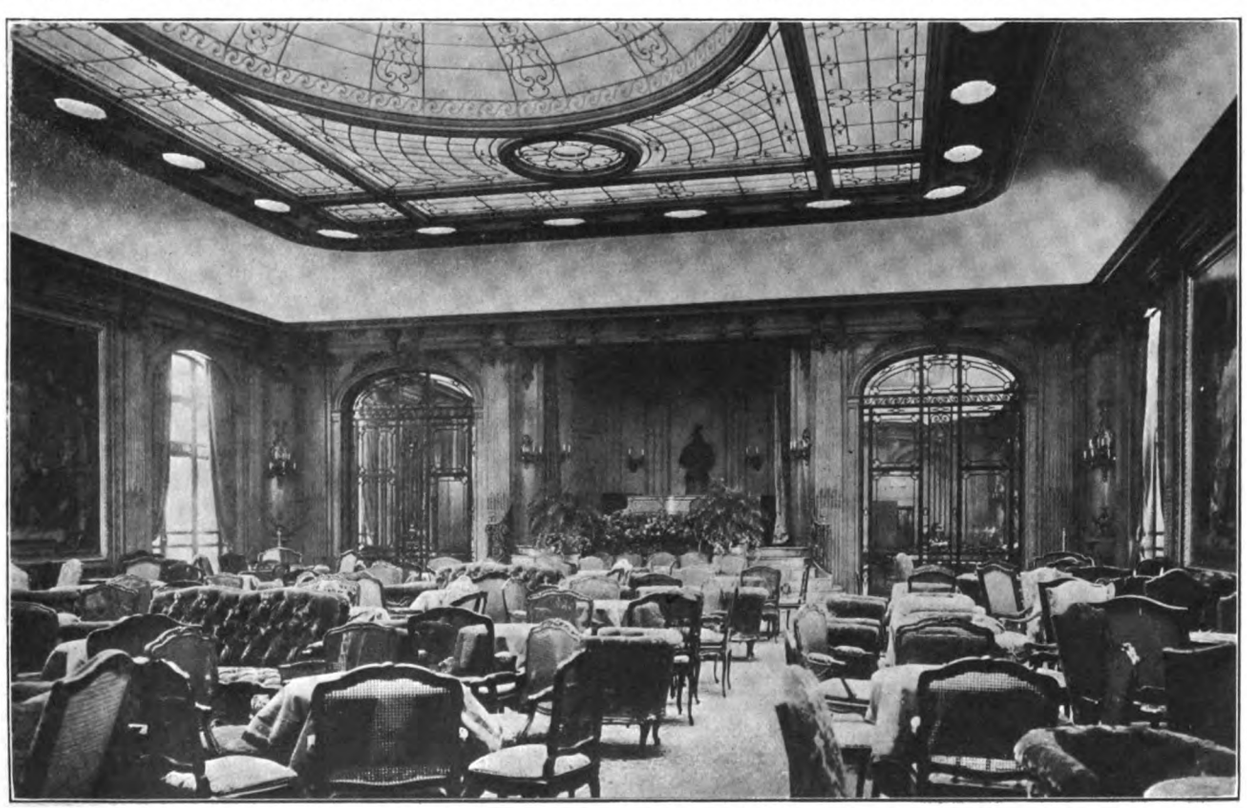

Fig. 2.—View of the Grand Saloon on the *Vaterland*

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motor boats carrying special wireless apparatus. The lifeboats are handled by Welin quadrant davits, with a complete equipment of lowering and hoisting appliances.

The wireless telegraph equipment of the *Vaterland* is the most powerful ever installed on shipboard. It comprises three separate sending instruments and includes six antennae. The special long-distance service equipment will keep the vessel continuously in touch with land throughout the Atlantic crossing. A second system will operate over 400 miles a day and 1,200 miles at night, while a third emergency outfit, operated by storage batteries, is kept in reserve. The wireless station is in charge of three operators, one of whom is constantly on duty.

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## The Rational Non-Diesel Marine Oil Engine*

BY ALBERT H. ZIEGLER

From the points brought out in the first instalment of this article it is evident that a successful oil engine must be designed and constructed to burn oils considerably heavier than kerosene (paraffin). This, in all probability, the carburetor type will never do.

Kindred to the exhaust-heated carburetor there is a type of so-called oil converter, which consists of a large muffler-size, double-wall, cast iron, exhaust-heated chamber, comprising a generator valve or a simple form of carburetor for the admission of the spray oil, and also a "butterfly" or other type of valve, which by-passes some of the engine exhaust gases through the converter as a means of heat regulation, according to the position of a throttle. The contrivance is really nothing more than an immense oil carburetor with a great expanse of exhaust-heated surface, from which the kerosene (paraffin) is vaporized by coming in direct contact with it. The effectiveness of this device is even less than that of the oil carburetor, as it is subject to all the same defects, only in an accentuated form. The oil is more liable to "cracking," and as the charges enter the cylinder at extremely high temperatures, and very much expanded, less power is developed for a given size of cylinder.

Another type of exhaust-heated, double-walled converter contains within the oil-gasifying chamber either a concentric series of cylinders of specially prepared fireclay and graphite with annular air spaces between their surfaces, or else the chamber is filled with balls of the same material. This gasifying chamber is surrounded by an exhaust chamber, and this in turn is covered with asbestos or other heat-insulating material. A generator valve or a simple oil carbureting device divides and sprays the fuel into this gasifying chamber directly upon the fireclay and graphite. Before starting the engine a small cover on one end of the gasifying chamber, and also a vent from the opposite end, are opened, and a blow-torch is directed against the clay until the clay becomes red-hot. The cover and the vent are then closed, and the engine is operated on gasolene (petrol) through a special carburetor on the engine inlet pipe. Meanwhile the oil is allowed to spread into the convertor, and when gas appears the gasoline (petrol) is shut off and the engine is run on oil-gas.

The oil generator valve on the converter, actuated by the cylinder inspirations, admits oil and a small quantity of air to the gasifying chamber. The oil is sprayed out over the red-hot clay, the small quantity of air present supplying only sufficient oxygen to burn a very small part of the oil admitted in order to keep the clay at a bright red heat. The balance of the oil is virtually roasted into a more or less fixed gas, and the carbon dioxide formed by the combustion of the heating oil combines with sufficient gasified carbon to convert it into carbon monoxide, and the whole combustible gas is piped to an air and gas mixing valve on the engine inlet pipe. Though the oil is undoubtedly "split" in contact with the red-hot clay surfaces, the heavier carbons adhering to them are gradually turned into a gaseous condition, and any incombustible components of the oil are carried away in the current of gas as very fine dust, which remains suspended, passes through the engine and out the exhaust.

In spite of the high degree of heat applied the gas produced is mainly an unfixed gas. Even though it is carried to the engine cylinders mixed with air at a temperature of about 400 degrees F., a certain amount of the heavier condensations forms on the upper walls of the inlet passages and pass into the engine cylinder in liquid form, causing gradual carbonization and fouling. Moreover, the highly heated and expanded cylinder charges materially reduce the power output for a definite cylinder size. The carbon dioxide and a small quantity of carbon monoxide, however, act as deterrents to premature and self-ignition, so that the engine compressions attained compare favorably with those of the gasoline (petrol) engines.

With this form of converter can be used the heavier kerosenes (paraffins), solar oil and gas oil with fair results, the consumption being in the neighborhood of .8 pound per brake horsepower-hour. The engine is reasonably flexible automatically from full load down to about 30 percent load, after which on continuous operation the heat in the converter drops to a point where either an external application of the blow-lamp becomes necessary, or the engine must be operated on gasoline (petrol).

Having found unfixed gas generators an unsatisfactory means of using oil fuels, many American manufacturers have attempted to use the out-and-out oil gas producer, in which the oil gas is passed through a comparatively vast bulk of white hot material in order to render such gases non-condensible. One such device consisted of an ordinary anthracite gas producer of small size in the center of the coal bed on which the oil fuel was sprayed, gasified and fixed in its passage through the bed to the outlet. All air for supporting combustion in the producer was admitted with the oil which it sprayed. The gas produced was then passed through scrubbers and to the engine, as in other gas producer installations.

Another type of oil gas producer consisted of a long, horizontally-arranged steel shell, lined with either asbestos or fireclay to a depth of several inches, more than half of the interior being filled with checker brick work or an extremely porous fireclay construction. A small opening in the vacant end of the chamber admitted an oil spray nozzle, through which the fuel was atomized into the chamber by means of either steam or compressed air. On being ignited, the flame from this atomizing nozzle rapidly heated up the entire interior to a dazzling white heat. The flame was then extinguished and the excess of air cut off, only enough air being admitted thereafter to maintain the proper degree of heat within the producer with a steady flameless, practically spontaneous combustion. The gases thus formed were taken out through the end of the producer opposite the sprayer, while an economizer heating the incoming air and oil surrounded the hot gas outlet pipe. The subsequent handling and application of the resulting fixed gases were as in the coal-fired producer.

These producers can be operated on any oil that can be made to flow through the atomizer. As the gases are passed to the engine in a cold, clean and non-condensible condition, the engine can be operated on a cold and unexpanded incoming charge with compressions of from 80 to 90 pounds, giving a power output not less than in a gasoline (petrol) engine. The oil consumption, however, is rather high, due principally to producer radiation and gas cooling. Also on account of the

* Continued from the May number.

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absence of extremely large gas holders, the automatic control of the oil feed and the maintenance of the proper interior temperature under varying loads becomes necessary, but this as yet has not been successfully accomplished. Moreover, the great bulk, weight, first cost, cost of operation and repair and sacrifice of valuable room on board ship, which any such fixed oil gas producers would involve, make such installations inapplicable to most classes of deep sea-going vessels.

By far the greatest amount of experimenting and research carried on by American marine oil engine builders has been along the lines of the hot bulb compression-chamber type. In this type the bulb is heated by a blow-torch for starting the engine, and the oil fuel is sprayed or more or less atomized into this hot bulb at the beginning of the suction stroke. Gasification of the oil is accomplished by the heat of the bulb aided by the heat of compresson, and this gas pours out of the bulb into the separately admitted air charge, the gas and air being mixed by whatever eddy currents may exist in the air charge during the suction and compression strokes. Ignition by electric spark is seldom resorted to, as the bulb acts as a tube igniter to all intents and purposes.

In such engines the cylinder clearance volume, or compression space, is practically all contained within the hot bulb, the engine inlet and exhaust valves opening into the cylinder proper at one side of the neck of the bulb. Thus the fresh air charges are taken into the cylinder cold and unexpanded, while the heat of the bulb is not greatly lowered or dissipated through the incoming charges, as these enter the bulb only upon being compressed, and therefore materially heated. Considerable combustion of the charge occurs in a non-water-jacketed chamber, conserving much heat that would otherwise be lost, while the heat of combustion serves to keep the bulb at a proper heat.

The oil sprayed into the red-hot bulb is, of course, "cracked," but the heavier carbon components adhering to the heated walls are all virtually roasted out into gas. The gases formed in the bulb, though by no means fixed, are not subjected to recondensation, as they do not have to pass through long, tortuous, cool passages.

The difficulties and shortcomings of the hot-bulb engine are due principally to the fact that with practically pure air against the piston and gas entirely unmixed with air at the opposite end of the bulb, there is only one point somewhere between these extremes where the gas and air are mixed in the proper proportions for complete combustion. This results in a somewhat smoky exhaust and a considerably lower mean effective pressure, and therefore a lower power output than would have been possible had the engine contained a charge of uniform non-stratified homogeneous gas and air mixture. The incompletely burned rich mixture end of the charge causes a slow sooting and gumming up of the combustion space, piston rings and valves. The low power output for a definite size cylinder is accompanied with a high fuel consumption, resulting in very incomplete combustion of much of the gas formed in the bulb. Though at full load the bulb temperature remains at an efficient gasifying and igniting point, as the load is decreased the temperature rapidly drops and serious difficulties arise, preventing further operation unless the blow-torch be put into service, or an electric ignition system applied, or both. These conditions may perhaps be permissible in a single-cylinder stationary engine, but they are inadvisable in a multi-cylinder marine engine.

Without proper provisions for the introduction of either water or water vapor into the cylinder of any engine compressing an intimately intermixed charge of air and oil fuel before ignition takes place, the degree of compression possible is ordinarily limited by the proneness to pre- and self-ignition, depending upon several functions.

The degree of compression attainable is dependent not only upon the ignition temperature of the charge before compression, the temperature of the in-take valves, passages, piston top, combustion space walls, the presence of small overheated parts, such as igniter electrodes, the sharp corners, fins and projections into the combustion space from the cylinder, cylinder head and piston, but also upon the chemical composition of the fuel used. All fuel oils contain not only considerable hydrogen (a gas easily set off by high compression), but also certain olefiant and marsh gases, having a tendency similar to that of acetylene to become easily ignited upon the application of heat and compression. Without the application of water in proper quantities and correctly delivered to the charge, non-Diesel oil engines would be limited to extremely low compression pressures, lower by far than is common with the gasoline (petrol) engine, whereas the proper use of water in such oil engines makes possible compressions far in excess of those found in gasoline (petrol) engine practice. German investigators have proved by actual experiments that with the proper use of water compressions approaching that of the Diesel engine caused no self or premature ignitions, and also that, due to such high compressions, the thermal efficiency of such non-Diesel engines was practically equal to that of the Diesel engines.

When water is atomized into the cylinder charge, it is, upon combustion of the fuel charge, dissociated into its component parts—oxygen and hydrogen. The process of dissociation absorbs much of the heat of combustion, thus considerably reducing both the maximum temperature and the maximum pressure of explosion and relieving the mechanical parts of the engine from excessive stress. Further down the stroke the oxygen and hydrogen recombine, setting free the heat absorbed from the burning charge at the upper dead center, thus increasing the temperature, and therefore the pressure, of the gases within the cylinder at a part of the stroke where the resulting pressure on the crank is more effectively delivered to the shaft in turning moment. The mean effective pressure is materially increased, the shock of explosion lessened, and a much smoother running engine produced. Also, due to the higher compression made possible, the thermal efficiency is greatly increased through the use of atomized water in the cylinder.

In summing up the above facts, it becomes evident that the American manufacturers may have very definite hopes for a practical and efficient non-Diesel type of the heavy oil engine, involving no greater weight, bulk, complication, cost of production, cost of operation, upkeep and repair, cost of experimenting and no extremely high-pressure equipment, and no greater skill or knowledge on the part of the operating engineer than is involved in the present large-size gasoline (petrol) marine engines. Such engines would burn as heavy and as cheap oils as any Diesel engine could handle, and the fuel consumption per brake horsepower-hour would be practically the same as in the Diesel engine.

*(To be concluded.)*

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RECONSTRUCTION OF THE S. S. GLENROY.—The steamship *Glenroy*, owned by the Royal Mail Steam Packet Line, which was extensively damaged by fire at Portland, Ore., in March, has been completely rebuilt at the yards of the Seattle Construction & Dry Dock Company, Seattle, Wash. The contract for the repairs was one of the largest handled on the Puget Sound in recent years and included taking off seventy-one plates, which were faired and returned; the removal and replacement of 23,000 rivets; the renewal of all joiner work in the vessel; the laying of a new teak deck; and the renewal of the bridge house, flying bridge, captain's quarters, chart room, poop deckhouse, and the port side of the fidley. The work was completed well within the contract time of thirty-one days.

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# The Watertight Subdivision of Ships and the Effect of Bilging—II

BY A. L AYRE

Watertight longitudinal bulkheads cannot be recommended for subdivision purposes generally, owing to the dangerous resultant effect on a vessel's transverse statical stability when one side only is bilged. A good deal is to be said in favor of their adoption in the case of dividing twin engine rooms, when in the event of one side being damaged the vessel still has some means of propulsion retained intact on the opposite side; but, even in such a case, a serious list may occur which might greatly impede, and perhaps prevent, the work of launching boats, and, further, in the case of a vessel with a fairly long compartment longitudinally divided on the center line, or a vessel without a large amount of righting arm of stability, it is quite conceivable that she would capsize as a result of the bilging of one side only.

The following example shows the effect of bilging one side of a 'midship compartment which has been divided by a longitudinal watertight bulkhead fitted on the center line in the case of a vessel 500 feet long by 60 feet beam by 26 feet draft, the block coefficient being .63, giving a total load displacement of 14,130 tons. The length of the bilged compartment is 100 feet.

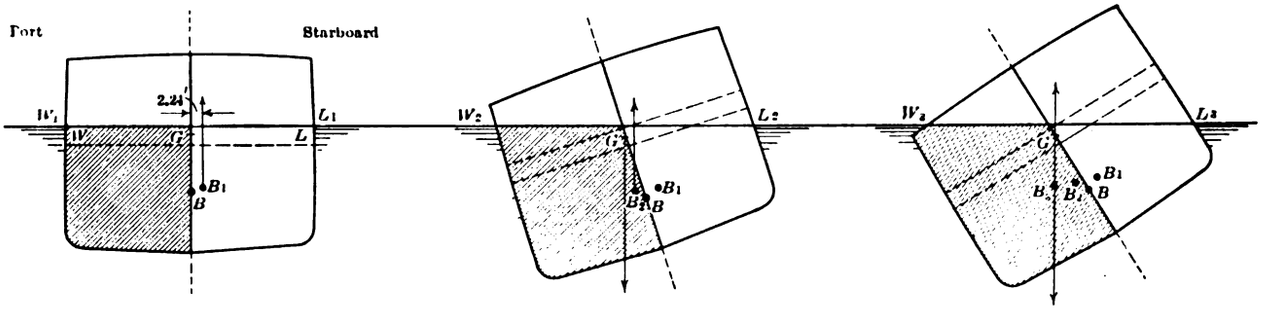


Fig. 3 Fig. 4 Fig. 5

Assuming the compartment to be empty of cargo, the lost buoyancy (one side only) is:

$$\frac{100 \times 30 \times 26}{35} \times .92 \text{ (coefficient of this portion)} = 2{,}050 \text{ tons.}$$

The center of gravity of this lost buoyancy is 14.72 feet from the center line.

The area of the load-water plane is $500 \times 60 \times .73 = 21{,}900$ square feet, and the area of the *lost* portion of waterplane in way of the damaged compartment is $100 \times 30 = 3{,}000$ square feet. The net area of intact waterplane is therefore $21{,}900 - 3{,}000 = 18{,}900$ square feet. The center of gravity of the lost area is 15 feet out from the center line, and on account of the removal of the waterplane area in way of the damaged compartment at this position, on the port side, say, the center of gravity of the new waterplane will have moved out to starboard to a position which is found as follows:

$$\frac{3{,}000 \times 15}{21{,}900 - 3{,}000} = 2.38 \text{ feet,}$$

this being the situation of the center of gravity of the new waterplane measured out to starboard from the center line.

This position will also represent the point above which the center of gravity of the added layer of buoyancy will be placed, and it is therefore seen that 2,050 tons of buoyancy is lost at a point 14.72 feet out on the port side and the same amount added at a point 2.38 feet out on the starboard side. This will give a moment of transference equal to $2{,}050 \times (14.72 + 2.38) = 35{,}055$ foot-tons, which also represents an upsetting moment of statical stability, and this divided by the total amount of displacement will give the new position of a center of buoyancy in the upright condition, and measured out from the center line towards the starboard side, $31{,}655 \div 14{,}130 = 2.24$ feet, which is the value of an upsetting lever of stability in the perpendicular condition of the vessel. In Fig. 3 the direction of the forces of gravity and buoyancy are shown for this condition, and according to the direction and relation of these forces it is seen that the vessel will incline to port. Another position may eventually be reached, as shown by Fig. 4, from which it is seen that the forces are still acting with a capsizing tendency. It will be noticed that the center of buoyancy has traveled in a port direction, owing to the inclination of the vessel, but that it has not traveled fast enough to overtake the line of force which acts downwards through the center of gravity.

Should it have happened that the center of buoyancy had moved out to port more rapidly during the inclination, so that it had reached a point vertically in line with the force of gravity, a position of rest, or angle of steady heel, would have been reached, as shown in Fig. 5; but in a case similar to the one under consideration, it is extremely doubtful if such a condition as this could be attained, and the most likely result is that the vessel will capsize.

In such circumstances, a vessel having a large amount of freeboard and initial statical stability would have the best chances of not capsizing, and should she have a watertight lower deck, which would arrest the amount of bilging in a vertical direction, and thereby enable the buoyancy in the topsides of the damaged compartment to be preserved, her chances would again be better still, as this would further assist the travel of the center of buoyancy to port during the inclination.

A representation of the relation of the upsetting lever to the curve of righting levers is given in Fig. 6, on the assumption that the center of buoyancy is traveling to port at the same rate as the variation in righting arm ($G Z$); but it should be remembered that on account of the loss of buoyancy in the topsides of the damaged compartment this could not always be expected. In any case it is seen that the net amount of upsetting lever, which will be the difference between the varying righting levers and the upsetting lever, is decreasing, but that in this case the righting levers—or the port travel of the center of buoyancy—does not reach an amount sufficient to overcome the amount of 2.48 feet of upsetting lever, and the vessel consequently capsizes. The curve of righting levers shown is one corresponding to the waterline $W_1 L_1$ in Fig. 3.

As none of the figures used in this example is by any means exaggerated the very great danger of longitudinal center line bulkheads is seen, and they should therefore not be recommended for use in the case of large passenger ships.

We may now proceed to consider the principal ways in which flooding may result from damage in various forms, the resultant effect of same and the methods of subdivision suitable for making provision against foundering.

*First.* The vessel running bow on in collision with another

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vessel or iceberg, etc. Should the vessel be runing at a high speed there will usually be extensive bow damage and flooding of the forepeak compartment. The safety of the vessel may not, however, be endangered, provided the shell damage has not extended aft of the collision bulkhead, that the collision bulkhead has not been damaged, and that the bulkhead is capable of withstanding any extra strain that may be brought upon it owing to the flooding of the forepeak compartment.

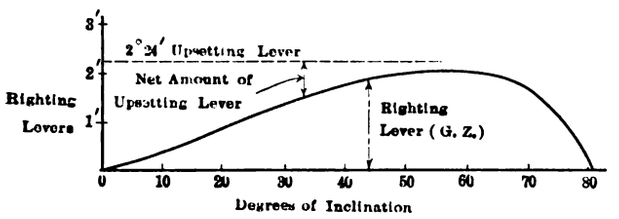


Fig. 6

In cases of severe impact it frequently happens that one of the foregoing provisions does not obtain, and the consequent flooding of No. 1 hold compartment takes place; while it is not unlikely, in cases where the collision flattens the bows back to the collision bulkhead, that the impact will be here imparted to longitudinal deck girders and by these transmitted to the next transverse bulkhead, so that straining may take place to the extent of destroying the watertight efficiency of same. In vessels without longitudinal girders beneath the decks it is not likely that the shock would be transmitted in this way, and the tendency is for the decks to spring or buckle, though its occurrence is quite probable in the case of heavy and rigid girders.

Should the second bulkhead be injured in this way it is, of course, obvious that after No. 1 hold has filled flooding of No. 2 hold will take place. It may also happen that the second bulkhead, *i. e.*, at the after end to No. 1 hold, will give way under the pressure of the water.

The buoyancy of the extreme fore end of the vessel for a length of 30 to 40 percent of the total length of ship may be lost as the result of such a collision, and a most serious change in trim would occur, which, even if it were possible for the vessel to remain afloat, would almost certainly, in average cases, render her unnavigable and unseaworthy.

So in order to guard as far as possible against total loss in such cases further subdivision than that provided by the transverse bulkheads is desirous. Longitudinal center line bulkheads are not suitable for the reasons previously mentioned, and it remains, therefore, to adopt the watertight lower deck as a means of minimizing the amount of flooding by limiting same in a vertical direction. Any heavy longitudinal girders fitted to this deck would be best stopped short of the collision bulkhead, and other compensating means of strengthening provided, and the risk of the impact being transmitted any further aft being thereby lessened.

*Secondly.* By the side shell plating being rammed between two transverse bulkheads by another vessel. In this case the flooding is not so serious as in the previous instance, so long as the loss of buoyancy is confined between two bulkheads, but the great necessity of these bulkheads being able to withstand the very great pressure is apparent.

*Thirdly.* One of the bows of the vessel coming in contact with submerged ice or wreckage, etc., in such a manner as to strip off or damage the shell plating over a large length of the vessel's side and thereby expose to the sea a large number of compartments. Fig. 7 shows a vessel damaged under such circumstances. It will be seen that four compartments are exposed to the sea as a result of the collision, and the buoyancy contained in about 45 percent of the vessel's length thereby lost.

This is probably the worst possible means of bilging, and while it may be rare in occurrence it is yet essential that some provision be made in the design so as to minimize the risk of subsequent foundering. In such a case the transverse bulkheads within the limits of the damage (excluding the endmost ones) play no part whatever in arresting the flooding, and without any additional means of subdivision the vessel must certainly founder. Such a vessel fitted with longitudinal bulkheads, which, while limiting the amount of lost buoyancy to one-half, would put the vessel in a much worse plight, would positively founder after capsizing owing to the resultant effect on the statical stability, as was seen in a previous example. There would, in fact, be much better chances of launching boats and saving life in the case of a vessel without the longitudinal bulkheads sinking by the head than in the case of the rapid transverse inclination and capsizing of the vessel if same were fitted.

It seems, therefore, that we must revert to the watertight lower deck, by means of which the flooding would be limited in a vertical direction, without having the disastrous effect on stability as occurs by limiting the amount in a horizontal direction.

*Fourthly.* The vessel grounding and receiving bottom damage either locally or over a large part of her length. This form of damage is, as a rule, of a most serious nature when resulting from grounding on a rocky bottom while running at a high speed. In such cases the great value of the cellular

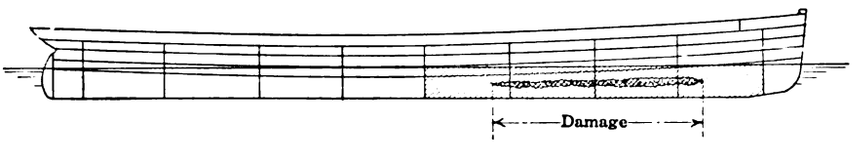


Fig. 7

double bottom is usually found, but occasionally the inner bottom is also pierced or its watertightness impaired by straining.

Should the damage be local the effect of the flooding on the reserve buoyancy will be similar to that of the collision damage between two transverse bulkheads, as mentioned in the second case above; but should it extend beyond one compartment—which is a very probable case—it is obvious that some further means of subdivision are desirable if the chances of floating the vessel are not to be endangered. In this case longitudinal center line bulkheads are of still less practical value owing to the great likelihood of the bottom damage occurring on both sides of the center line. It is again seen that the most effective way in which to restrict the flooding will be to do so vertically, and this by means of the watertight lower deck.

A further effect to consider is that of strain resulting in either of the above cases owing to the impact and to the subsequent flooding and loss of buoyancy. The strain effect may be put under three heads, as follows:

1. Accruing from impact.
2. Pressure of water against bulkhead which is unsupported on opposite side.
3. The loss of buoyancy and the insufficient support remaining for the weight contained within the space.

The first may cause the gradual bilging of another compartment owing to the calking and riveting being "started,"

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so as to render inefficient the watertightness of other vital portions of the structure.

The second may have results similar to those of the first, with the further danger of the bulkhead giving way at any moment and the consequent rapid flooding of the adjacent compartment.

The third may be the means of severe general structural stresses being set up, having the same strain results as in the case of the first. These stresses may even reach such a magnitude as to cause the breaking of the vessel into two parts, as the result of the redistribution of buoyancy following on the bilging.

(*To be continued*)

## The Design of Boats for the New York State Barge Canal

A problem which deserves much more attention on the part of vessel owners, naval architects and shipbuilders than it has yet received is the design of suitable boats for operation on the New York State Barge Canal. The canal will be opened for transportation within the next year or so, and it is estimated that millions of tons of grain, coal, iron ore and other raw material will pass through the canal each year.

The length of the canal from the Niagara River terminal to the Hudson River is 323 miles. In addition to the main canal there will be several branches to Lake Champlain, Lake Ontario, Cayuga Lake, Oneida Lake, etc. While the greater part of the traffic through the canal will consist of bulk cargoes, such as coal, ore, grain, etc.; it is believed, however, that lines for fast freight or package service will be encouraged, and this service will call for more or less traffic throughout various parts of the canal. The nature of the traffic, therefore, seems to call for two types of boats, one of the largest possible capacity for through-bulk freight, and the other of smaller dimensions for local package freight.

In order to develop the best type of boat for the canal service, INTERNATIONAL MARINE ENGINEERING offers to publish designs or suggestions from its readers which will aid in establishing the best form of hull for such service, the most efficient system of propulsion and also the most economical methods of loading and unloading the vessels. As, of course, the most suitable design of boat for this service depends upon the physical characteristics of the canal, its locks and the port facilities, the following points should be borne in mind:

In the thirty-five main canal locks, in which the distance between gates is 338 feet, the maximum space for locking purposes is 310 feet in length, 45 feet breadth and 12 feet depth of water over the sills. This, generally speaking, is sufficient to accommodate a 3,000-ton barge. The depth of water in the canal prism will also be 12 feet. At several points in the canal, where there are 4-degree curves and a 75-foot channel, two boats 300 feet long and 22 feet beam could pass with a space of 8½ feet between them. Boats of the maximum dimensions corresponding to the locking capacity could pass through any portion of the canal, but, in the restricted portions, one boat could not pass another.

It is understood that the use of so-called paddle-wheel boats will not be permitted, but otherwise no definite regulations have as yet been made. Speed limits will be about six miles per hour in the narrow parts of the canal, although considerable more speed will be permitted in the lake and river sections, probably up to 12 miles an hour. Besides the tonnage and speed limits, head room is limited to a maximum of 15 feet 6 inches, owing to low bridges or other overhead obstructions. Under the present law, the season of navigation in the canals of the State begins May 15 and ends November 15. It is not probable that this law will be changed materially.

It is believed that eventually two types of boats will be adopted, one that will have sufficient strength of construction and enough freeboard to adapt them to the roughest service on the Great Lakes as well as outside of New York harbor, and that these boats will have the maximum capacity permissible and will be operated by their own power. Whether these boats will tow barges of the maximum size, or of smaller size, remains to be seen. The second type of boat will be of smaller dimensions and designed exclusively for use in the canal and its branches and adjoining rivers.

The report of the Barge Canal Terminal Commission states that the average cost of railroad haulage of freight per ton between Buffalo and New York is $1.96 (8s. 2d.), while the engineers of the Commission estimate that the cost of carrying a ton in efficient boats by the canal will be only 26 cents (1s. 1d.) As to the actual tonnage of freight that will pass through the canal no definite estimate can be made. At the time the canal was planned an estimated tonnage of 10,000,000 was borne in mind, but the water supply is sufficient for twice this tonnage.

In view of the fact that facilities for cheap transportation over such an important thoroughfare will soon be available, naval architects and shipbuilders should take this problem in hand at once and bring out designs or suggestions which will aid in determining the most suitable type of boat for this service.

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SHIPPING OF THE PORT OF LONDON.—The annual report of the Port of London Authority for the year ended March 31, 1913, shows an increase in the value of the trade of the port, but a decrease in the tonnage in consequence of the coal strike in March and April of 1912, and of the general strike at the port during the months of May, June and July. There was a net decrease of 986,849 tons as compared with the previous year. The tonnage of vessels that arrived and departed with cargoes and in ballast from and to foreign countries and British possessions and coastwise during the calendar year of 1912 was 37,676,142 as compared with 39,179,153 in the year ended December 31, 1911. The net registered and dock cargo tonnage of ships that entered and left the port and paid river tonnage dues during the twelve months ended March 31, 1913, compared with the preceding twelve months, were as follows: 1913, foreign, 19,632,865; coastwise, 8,875,807; total, 28,508,672. 1912, foreign, 20,101,634; coastwise, 9,393,887; total, 29,495,521. The shipping that use the wet docks and paid river tonnage dues, exclusive of vessels to and from the estuary and Medway, was: foreign, 15,179,104 tons as compared with 15,585,453 tons in the preceding fiscal year; coastwise, 1,979,328 tons as compared with 1,989,095 tons in 1911-1912; total, 17,158,342 tons as compared with 17,574,548 tons in 1911-1912. The shipping entering the dry docks of the Authority during 1912-1913 was 114,899 tons less than that of the preceding year, the tonnage being 2,158,073 in 1911-1912 and 2,043,174 in 1912-1913. During the year under review contracts were entered into in connection with the Dock Improvement scheme, representing an expenditure of about $12,190,582 (£2,500,000). The principal improvements consisted of the building of sheds, the erection of hydraulic and electric cranes, the installation of a power plant (at the Millwall dock), the provision of additional warehouse space, the furnishing of better railway accommodation and the reconstruction of a grain elevator.

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CITY OF ROME DESTROYED BY FIRE.—The freight steamer *City of Rome*, bound from Buffalo to Toledo, was totally destroyed by fire May 7. The fire was discovered in the forward hold of the vessel shortly after midnight, and the vessel was immediately headed for the nearest shore, although before reaching the shore the crew was forced to take to the boats and abandon the vessel. The *City of Rome* was built in 1881. She is 265 feet long, with a capacity of 3,500 tons. Captain William Dunn commanded the vessel; Thomas Cunningham, of Milwaukee, Wis., had charge of the engine room, and C. E. Derew, of Chicago, was assistant engineer.

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# Letters from Practical Marine Engineers

**Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs**

## A Condenser Breakdown

The illustration shows a condenser which broke down recently on board a steamer engaged in cross-channel service. It also shows that in repairing it a very elaborate casting was dispensed with which at the time the condenser was designed (about twenty-five years ago) was considered to be the correct thing.

The condenser was of cast iron and of the double-flow type. The cooling water entered the water-box at the inlet *A*, and flowed through in the direction shown by the arrows. The

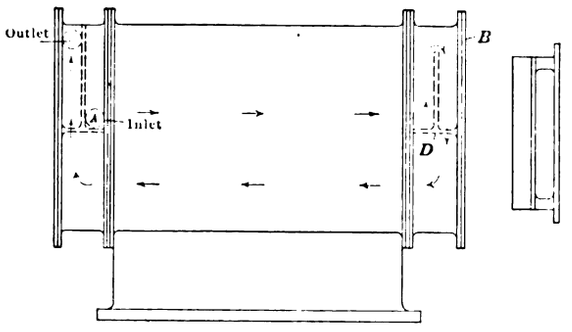



Fig. 1



Fig. 2

circulating pump was driven off the main engine, and one night in heavy weather the door *B* cracked badly. However, good stout shores were put in between one of the engine columns and the door, enabling the ship to get into port. She was due to sail again the next day, but the door was found to be so badly damaged that it was quite impossible to patch it.

A ¼-inch thick malleable iron plate was sheared to shape, drilled and put on without the partition *D* with vertical baffle plate, which was cast on the old door. The vessel sailed next morning, and the condenser proved just as efficient as ever. Fig. 2 shows a plan of the original door. J. Swan.

## Further Remarks on the Corrosion of Boilers Using Sulphurous Oils

Referring to my previous notes on the "Corrosion of Boilers Through the Use of Sulphurous Oils," published in the May number of this paper, the following supplementary remarks are submitted:

Since writing the first notes I have attempted to prove that the formation of sulphuric acid, as stated therein, is entirely practicable. My apparatus has not been of the best, so it has not been possible for me to duplicate the conditions found in the furnace, but my results have been fairly satisfactory.

In my first experiments I burned a small quantity of sulphur (about 1 gram) in a vessel containing practically pure oxygen and in which I had previously placed several pieces of sulphur-free firebrick. After the sulphur was burned the vessel was placed in an oven and kept at a temperature of 125 degrees C. for about two hours. At the end of this time the pieces of brick were removed and placed in a beaker containing distilled water. The liquid was filtered off after a suitable length of time had elapsed, and a little barium chloride was added to it. The white precipitate of either barium sulphate, barium sulphite, or both, promptly appeared. In order to eliminate the sulphite, the precipitate was boiled with hydrochloric acid. Although the greater part of the precipitate disappeared during this boiling enough remained to show that a small quantity of sulphuric acid had been present in the liquid.

As a further experiment, about 2 grams of sulphur was burned in air in an oven in which pieces of firebrick had been placed. In order to cause the sulphur to burn at a high temperature, as it would do in the furnace, it was ignited by dropping it upon a hot iron plate placed in the oven for this purpose. An oven temperature of 130 degrees C. was then maintained for about two hours. At the end of this time the brick was tested as before with practically the same results.

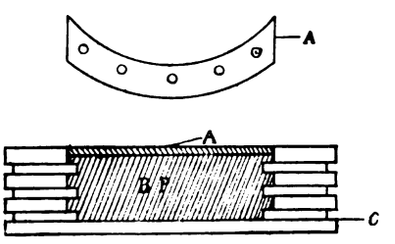
The sulphite reaction above mentioned was caused by the presence of considerable quantities of $SO_2$ (the principal product of the combustion of sulphur in air) in the brick. This reaction was to be expected. In each case, however, there was a small amount of sulphuric acid present, which tends to confirm the theory given in the May number of this paper.

In my previous notes I neglected to say that the white precipitate formed by the action of $BaCl_2$ might be either a sulphite or a sulphate, and that it is necessary to eliminate the sulphite by boiling with hydrochloric acid. Of course, there are some other compounds which might cause a similar reaction, but their presence is not to be expected in a boiler under ordinary circumstances. As a means of acquiring certainty in every case of doubt it is well to submit samples of the material to be tested to a chemist for analysis. The analysis is simple, would not be expensive, and would probably be a good investment in the end. W. W. B.

## Successful Arrangement of Piston Rings on Horizontal Marine Engines

Horizontal engines on board ship differ from those ashore in this respect, that the engine-room space on board ship is limited and no tail rod with guide can be fitted to keep the piston on the center of the cylinder. Therefore, there is generally excessive wear along the bottom side of the cylinder and piston.

The illustration shows how this can be remedied. After running for a short time, the piston of a horizontal engine becomes such a good fit for the cylinder along the bottom side that you could dispense with the ramsbottom rings or




Arrangement of Piston Rings

other packing on the bottom. Working on this idea, the sketch shows how the pistons of a paddle engine were altered and now give the engineer no trouble.

The pistons were taken up to the shop and for about a fourth of their circumference were slotted out to the depths of the ramsbottom ring grooves, but not right through the whole depth of the piston, the cut being stopped at the face of the last groove, as shown at *C*. The bronze plate *B P*

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was then fitted into this. The junk ring was cut out in the top to a depth of ⅝-inch to receive a bronze locking plate *A*, which was held in position by the junk ring studs.

When the piston was in position, the ends of the bronze plates were perpendicular and parallel to one another in order to permit packing being slipped in between the plate *B P* and the piston to make up for any wear and still keep the ends a good fit to the piston. The ramsbottom rings were cut so that they would project into the plate *B P* about 1 inch. The plate *B P* was not pinned on to the piston in any way, but was just held in position by the locking plate *A*.

Those pistons ran so successfully that the other paddle engines in the same fleet were altered accordingly.

J. SWAN.

## Air Pumps

The writer was reminded by one of the questions in the final chapter of "McAndrew's Floating School" in the April issue of the INTERNATIONAL MARINE ENGINEERING of some experiences he has had with air pumps, the relation of which may prove interesting to all and possibly instructive to the younger marine engineers.

One of the first vessels he served on was an old wooden coastwise ship, fitted with a single engine which originally was jet condensing, but at this period a surface condenser had been installed. The air pump was attached to the main engine crosshead, and was not altered any when the surface condenser had been installed, except to change the suction channel. Having been designed for jet condenser duty, thus having to take care of the condensing water as well as the vapor and condensed steam, it was considerably larger than was necessary for surface condenser duty, a meritorious fault, by the way. The peculiar circumstance connected with this air pump was that it was not fitted with a foot valve. The bucket and delivery valves were single valves, made of soft rubber, fastened in the center, and at each stroke of the pump they curled up at the edges around a convex guard. This air pump performed all the duty required of it in a perfectly satisfactory manner without a foot valve, 28 inches of vacuum being maintained in the condenser without any difficulty. Being of such ample size there was little trouble experienced with the valves or packing, and the writer has never known of an air pump that gave better service with as little trouble than did this one.

On another ship of the same type the air pump was also of large size, having been installed for jet condenser duty but used after a surface condenser had been installed. This pump was fitted with foot, bucket and delivery valves, all of the single type as described in the first part of this article. While proceeding down the James River, Va., the delivery valve carried away just as the ship was making a landing. When the ship had been made fast to the dock the bonnet over the delivery valve was taken off, when it was discovered that the convex guard was broken beyond repair and the valve torn in several pieces. There was no spare guard on board, but the chief engineer decided that the trip home could be made without a delivery valve, and when the debris had been removed from the valve chamber the bonnet was replaced and the voyage continued. So far as could be noticed this air pump worked as satisfactorily without this valve as it ever had done with it, the same vacuum being maintained the remainder of the trip. The writer, then a young man, asked the chief why this delivery valve could not be done away with entirely, and was informed that if the foot valve carried away with the delivery valve in good condition the air pump would continue to perform duty, but without the delivery valve in case of accident to the foot valve the air pump would be useless, a piece of information that was valuable to a young man learning the business.

Some years later, when the writer had advanced in his profession, he was chief engineer of a coastwise tugboat, fitted with triple-expansion engines with the air pump attached to the intermediate-pressure crosshead. This air pump was of the usual type of modern construction, having six straigh lift valves each in the foot, bucket and delivery. One afternoon the assistant engineer reported that the vacuum had suddenly disappeared. No difficulty was experienced in locating the trouble. The steam was being properly condensed and there were no air leaks anywhere, so that the only explanation was that a bucket valve had carried away. The water was flowing through the air pump and hotwell to the filter box, whence the feed pumps were taking it and putting it back into the boilers, so it was decided to proceed on the voyage, as it would be extremely inconvenient, if not hazardous, to stop for repairs with a tow of barges at this time and place. The voyage was completed without difficulty, the engines only making five or six revolutions less per minute on account of the loss of the vacuum. On arrival in port the air pump was stripped and a stud in one of the valves was found to have pulled out of the grating in the bucket. The guard was badly battered out of shape but no other damage done. Spare guards and valves were carried on board and the hole in the grating was reamed out and tapped larger, a special stud made with end to fit and the air pump was soon in shape again.

These experiences show that an air pump will work without either a foot or delivery valve but not without both, nor will it work without the bucket valve being in proper condition.

J. S.

## The Loss of the Oklahoma as Viewed by the Bureau Veritas

The administration of the Bureau Veritas have had their notice drawn to the findings of the Local Inspectors at Boston, Mass. (as reported to the Supervising Inspector General, Steamboat Inspection Service, Washington, D. C.), on the loss of the steamship *Oklahoma* on January 4, 1914. In their findings the Local Inspectors state that the loss of this vessel "demonstrates the fact that the rules of the Bureau Veritas may be faulty," yet an examination of the findings, based, no doubt, on the evidence given by the survivors of the crew, fails to show that there was any definite reason for coming to such a decision.

The facts of the case are briefly as follows: The steamship *Oklahoma* left the docks at Bayonne at about 1 P. M., January 3. She had ballast in Nos. 4, 6 and 7 tanks and fuel oil in No. 2 wing tanks, and also in the fore peak. On the way down the Bay No. 5 tank was cleaned out and was apparently ready to receive water ballast shortly after the vessel passed the Scotland Lightship, at about 3 P. M. Outside, the sea was found to be rough and the wind blowing hard. The condition of the weather was such that after passing outside the vessel was slowed down to a speed only sufficient to keep her head to the wind. This clearly proves, when such a large vessel as the *Oklahoma* had to be nursed so carefully, that the weather conditions were rather severe. The captain decided to take in more water ballast, and No. 5 tank was pumped up. The grave risks taken by such a procedure will be commented on hereafter. The weather gradually grew worse during the night. The wind was almost of hurricane force and mountainous seas were running. Early on the morning of January 4, two other tanks, Nos. 3 and 8, were pumped up, and this was not completed until some time after 4 A. M., *i. e.*, over thirteen hours after passing the Scotland Lightship. The ship made very bad weather all night, as the decks were awash and the vessel almost hove to. At about 7 A. M., on January 4, some of the officers and crew noticed a slight buckling of the deck in way of No. 5 tank

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which they did not think was serious. About 9 A. M. the same morning, while the vessel was poised on two seas, the vessel broke completely into two parts in way of No. 5 tank, which is near amidships.

The grave risks and dangers of damage to the structure of the vessel by pumping in large quantities of water ballast under such severe weather conditions are readily acknowledged by those best able to judge, and so clearly is that recognized that the rules of the Bureau Veritas specify that one of the conditions of the classification of such vessels is that: "It should be understood that on no account is water ballast to be pumped in or out of the holds or cofferdams at sea, beyond that which is necessary for keeping tanks full in case of leakage." Therefore, it is clear that the conditions of classification were violated in this instance. That such severe treatment of the structure of the vessel contributed greatly to the eventual failure will be readily admitted, yet there is no mention of this grave risk in the official report. In fact, it is inferred that it was a quite proper procedure to take.

There may be extreme cases where the masters of such vessels have to take such risks, as a last resource, but if the structure fails under these trying circumstances, that does not prove that the rules of the registration society to which the vessel was built are faulty. The administration have stated the facts, as known by them, regarding the severe treatment to which the structure of the vessel was subjected, and they feel sure that when these facts are placed before anyone, in a position to form an intelligent opinion on the matter, they would unhesitatingly confirm the administration's opinion that this severe treatment very likely led to the breaking in two of the vessel.

It is very strange, too, that in hinting at the faultiness of the rules of the classification society to which the vessel was built, little or no notice has been taken of the past performances of the vessel. The vessel was built in 1908 at Camden, New Jersey, since when she has been regularly employed in the carriage of oil cargoes. On her preceding trip the ship had delivered a cargo of refined oil, consisting of several different grades, the character of which would not permit of even the slightest mixture. This indicates that the bulkheads were in good condition. This cargo of oil was delivered practically free of any water, and without loss, proving that no sea water had leaked in and that no oil had leaked out through the shell. Moreover, the vessel had made a great number of successful trips across the North Atlantic, during some of which she experienced much worse weather and higher seas than existed at the time of her loss. With such a record of good service to her credit, it seems very unreasonable to infer that the rules to which she was built may be faulty, and that the loss of the vessel may be attributed thereto.

This surely points to some other cause for the failure of the vessel's structure, and gives good grounds for the suggested reason, as stated above. It is also interesting to note that the captain and officers of this vessel never had occasion to notice any weakness whatever in the vessel, prior to the morning of her loss, and they considered the vessel strong and seaworthy.

With reference to the statement in the finding, "that because a small amount of re-riveting was necessary at different times during the life of the vessel, this demonstrates and proves that there was unusual work and motion in the hull of the ship," it is clear that the local inspectors who drew up the official report are not conversant with the work usually necessary for the upkeep of such vessels. Every bulk oil-carrying vessel has to have the riveting of the tanks overhauled from time to time, but this in no way proves that the structure of the vessel is weak.

The shipping world will be interested to have further information as to the standard of construction that the local inspectors wish to set up, and also on what experience that standard is to be based. If it is to be a standard which will make the vessels "capable of enduring, without damage to the structure, every possible strain which might be brought to bear upon it, without restriction," such as the filling of tanks with water ballast in bad weather, then the owners of such vessels must be prepared for a very considerable increase in the weight and cost of such vessels trading to United States ports in the future. That such increases are not justifiable is readily proved by the successful running of the large number of bulk oil-carrying vessels which are constructed to the rules of the various classification societies. The rules of these societies have been built up from long experience, yet no classification society would venture to guarantee that the structure of a bulk oil-carrying vessel built to its rules would be immune from failure if subjected to extreme treatment outside of that usually accepted as fair and reasonable and as a condition of classification. BUREAU VERITAS.

New York, N. Y.

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## An Interesting Boiler Repair

The twin-screw steamship *Canada,* 11,440 tons, of the Austro-American Line, is one of the largest vessels entering Montreal harbor during the present season. She is, moreover, one of the largest emigrant ships in the world, having accommodation for over 3,000 steerage passengers, together with a crew of 160.

The *Canada* is propelled by quadruple expansion engines fitted with Walschaert valve gear, and steam 215 pounds pressure is raised in four boilers of the Scotch type. Each of the latter has three furnaces, the two center boilers being single-ended, while the port and starboard boilers are double-ended. On the ship's first voyage to Montreal from Trieste last season, she met with a mishap which put the port boiler out of commission. She had a very light cargo on that trip, and was only drawing 13 feet forward and 21 feet aft, as against her normal draft of 30 feet when fully loaded.

The incident took place in the afternoon when off the Banks of Newfoundland. The *Canada* had on board 2,300 passengers, the majority of whom were on deck at the time. A strong northeasterly wind sprang up suddenly, and as there were numerous icebergs in the vicinity this wind was very cold, causing the passengers to make a concerted rush to the lee side of the deck houses. This movement, combined with the strong wind, gave the vessel a bad list to port, with the result that the crown sheet of the starboard combustion chamber of the port boiler became overheated and collapsed.

There were 3 inches of water in the glass at the time, and directly the ship listed extra feed was given to all the boilers. At the same time the starboard tanks were filled as rapidly as possible in an endeavor to bring the ship again upon an even keel. These measures took about ten minutes, by which time the crown sheet of the combustion chamber in question had been badly burned. It collapsed in pockets between the stay-bolts, causing the holes of the latter to become enlarged, although the bolts did not actually pull out. There was, however, a serious leakage of steam and water into the furnaces.

The ashpan and up-take dampers were immediately closed, and the fires drawn. The latter operation proved rather a difficult one owing to the escaping steam, but fortunately no one received injury.

### MAKING THE REPAIR

The voyage was continued with three boilers, and on Montreal being reached repairs to the damaged combustion chamber were at once undertaken by the Hall Engineering Works of that city.

The combustion chamber top was 4 feet 2 inches wide by 5

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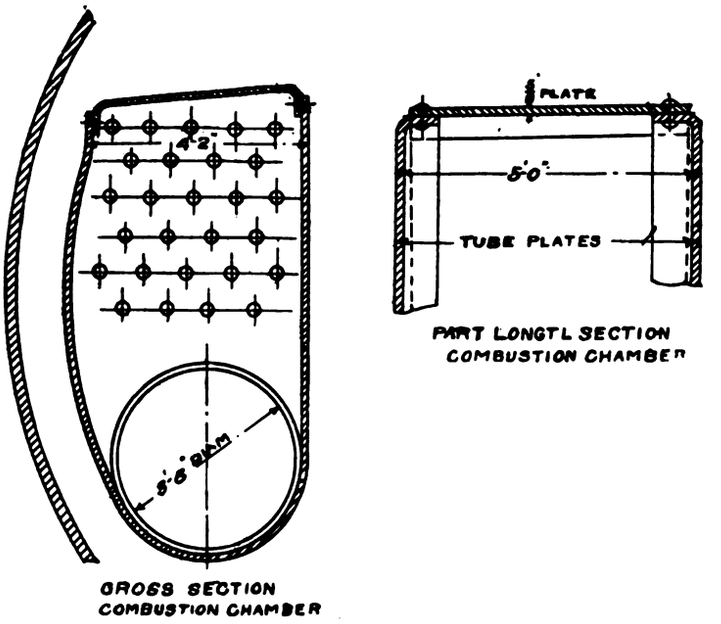


Fig. 1

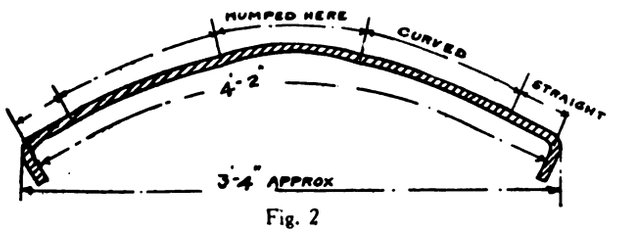


Fig. 2

feet long, and it was desired to have the new crown sheet made from a single plate, but the internal diameter of the corrugated furnace was only 3 feet 6 inches, so that at first sight there seemed to be no choice but to use two plates and have a riveted joint along the top of the chamber. Such a joint would, of course, have been highly undesirable in such a location, and the manner in which the necessity for it was overcome is shown in the accompanying cuts.

The crown sheet, it should be mentioned, was 5/8 inch thick and of ordinary boiler plate quality—60,000 pounds tensile strength. It was flanged on two edges to make the joint with the combustion chamber side sheets, as indicated in Fig. 1. In order to get it through the flue it was determined to roll it to a curve, as shown by Fig. 2. A piece of 1/8-inch plate was first taken and cut to the dimensions of the crown sheet. This plate was then flanged, so that it formed a true templet of the heavier plate. It was then put through a set of rolls and various trial curves given to it until it would pass easily through the flue. The curve did not extend the full width of the plate, a portion of the latter being left flat near each of the two flanges. A rather sharper radius was given along the longitudinal center line than elsewhere, the general shape of the curve being shown in Fig. 2.

The templet having been satisfactorily shaped, the crown sheet was rolled to the same curvature. It was then transported from the Hall Engineering Works to the ship, where it easily passed through the furnace flue into the combustion chamber.

The next step was to raise the plate and place it upon the top of the forward tube sheet with the flanged edges in a fore-

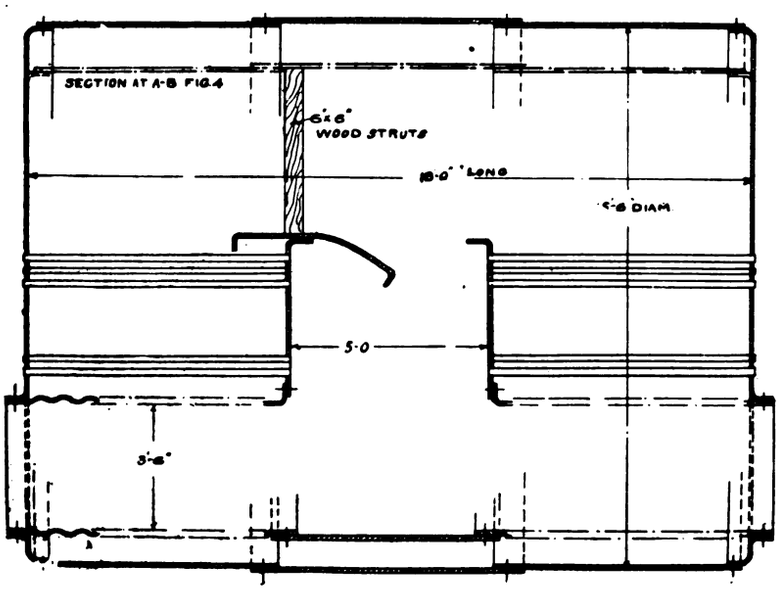


Fig. 3

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and-aft direction; that is, in a position at right angles to the direction they were to eventually occupy. This is shown in Fig. 3.

STRAIGHTENING THE PLATE

The plate having been got into the position indicated, stout timber struts were fitted between it and the boiler shell. These served to hold it securely while one-half was gradually straightened out by hydraulic jacks. When this had been satisfactorily accomplished, the plate was removed to a similar position on top of the other tube sheet, and the straightening operation repeated on the other half. The plate was practically straightened cold, it only having had "the chill taken off," in order to avoid the risk of setting up serious stresses in the metal.

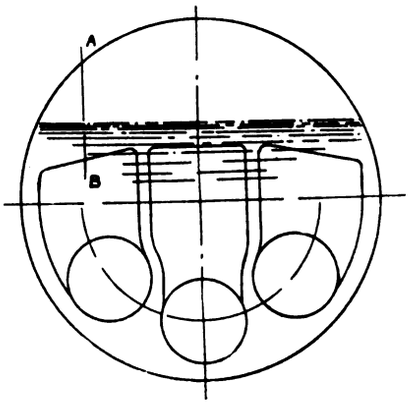


Fig. 4

All that now remained to do was to turn the plate round into its final position and drill it for the rivet and staybolt holes. The rivets were then driven, the girder stays replaced, and, in just a week's time from the commencement of the job, the boiler was ready for steam again. Of course, work was carried on night and day; but, even so, the performance was a good one. Turning the plate around and afterwards straightening it were two very awkward operations in the cramped quarters afforded by the combustion chamber; and that the work was satisfactorily accomplished speaks well for the facilities to be found at the port of Montreal, and the resourcefulness displayed and the emergency equipment available at the Hall Engineering Works there.—*Canadian Machinery.*

## Marine Engineering Academy

The Marine Engineering Academy, 80 Broad street, New York City, formerly owned by Theo. T. Mercereau, is now under the management of Educational Department of the West Side Y. M. C. A. of New York City. The academy was established in 1904 by Thomas H. Barrett, and was subsequently taken over by Theo. T. Mercereau, under whom more than 700 men have been trained to become marine engineers. The new management has taken up the work of training men to become marine engineers not solely upon the advice of men who have had experience in this particular phase of education, but also upon the counsel of prominent steamship men, who have welcomed the event of reorganizing and continuing the academy, as a means through which they may secure more efficient and better trained engineers.

In order to make it easier for men to secure licenses as marine engineers a thorough course of instruction has been planned to meet the difficulties most often encountered by candidates. The school will cater not only to local patronage but to the future engineers of the entire country. Through investigation it has been found that there are men throughout the country who hesitate to come up for an examination because they feel that there is some requirement, such as mathematics, which they would not be able to pass, and they are unwilling to place themselves in a position to be humiliated by failure. On account of a total ignorance of the actual topics touched upon by the examination the tests appear much more formidable than they really are. The object of the school is to encourage and assist any such hesitating men. They will be given the needed instruction along the line of the questions asked, and will be coached in the proper manner of going about securing their licenses. The course planned deals exhaustively and thoroughly with the various mathematical calculations marine engineers are called upon to make.

Mr. Mercereau will remain with the school in the capacity of advisor, and Mr. John L. Moran will be the instructor in the new course. The advisory committee consists of Robert E. Todd, ex-commodore, Atlantic Yacht Club; Arthur Curtis James, ex-commodore, New York Yacht Club; Capt. George S. Runk, member Larchmont Yacht Club, and Edward L. Wertheim, educational director of the West Side Y. M. C. A.

## Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

BATTLESHIPS

| | Tons. | Knots. | | Feb. 1. | May 1. |
|---|---|---|---|---|---|
| New York | 28,000 | 21 | Navy Yard, New York | 96.4 | 100.0 |
| Texas | 28,000 | 21 | Newport News Shipbuilding | 98.3 | 100.0 |
| Nevada | 28,000 | 20½ | Fore River Shipbuilding Co. | 55.2 | 63.9 |
| Oklahoma | 28,000 | 20½ | New York Shipbuilding Co | 60.8 | 67.2 |
| Pennsylvania | 31,400 | 21 | Newport News Shipbuilding | 17.0 | 29.1 |
| No. 39 | 31,400 | 21 | Navy Yard, New York | 4.7 | 11.5 |

TORPEDO BOAT DESTROYERS

| | | | | | |
|---|---|---|---|---|---|
| Downes | 1,010 | 29 | New York Shipbuilding | 93.7 | 95.3 |
| Balch | 1,010 | 29 | Wm. Cramp & Sons | 92.6 | 100.0 |
| O'Brien | 1,050 | 29 | Wm. Cramp & Sons | 42.1 | 62.2 |
| Nicholson | 1,050 | 29 | Wm. Cramp & Sons | 42.1 | 60.5 |
| Winslow | 1,050 | 29 | Wm. Cramp & Sons | 40.3 | 54.4 |
| McDougal | 1,050 | 29 | Bath Iron Works | 66.6 | 89.3 |
| Cushing | 1,050 | 29 | Fore River Shipbuilding | 32.0 | 41.5 |
| Ericsson | 1,050 | 29 | New York Shipbuilding | 40.9 | 61.6 |
| No. 57 | 1,090 | 29½ | Fore River Shipbuilding Co. | 6.8 | 9.4 |
| No. 58 | 1,090 | 29½ | Wm. Cramp & Sons | 2.6 | 6.8 |
| No. 59 | 1,090 | 29½ | Wm. Cramp & Sons | 2.5 | 6.7 |
| No. 60 | 1,090 | 29½ | Bath Iron Works | 7.2 | 17.5 |
| No. 61 | 1,090 | 29½ | New York Shipbuilding Co. | 8.9 | 9.8 |
| No. 62 | 1,090 | 29½ | New York Shipbuilding Co. | 8.9 | 9.8 |

SUBMARINE TORPEDO BOATS

| | | | | | |
|---|---|---|---|---|---|
| G-4 | .... | .... | Wm. Cramp & Sons | 96.4 | 96.4 |
| G-2 | .... | .... | Newport News Shipb'g Co. | 89.7 | 89.7 |
| G-3 | .... | .... | Lake T. B. Co | 80.3 | 81.6 |
| K-1 | .... | .... | Fore River Shipbuilding Co. | 99.2 | 100.0 |
| K-3 | .... | .... | Union Iron Works | 91.7 | 94.0 |
| K-4 | .... | .... | Seattle Con. & D. D. Co. | 89.4 | 93.9 |
| K-5 | .... | .... | Fore River Shipbuilding Co. | 88.9 | 92.8 |
| K-6 | .... | .... | Fore River Shipbuilding Co. | 88.7 | 92.8 |
| K-7 | .... | .... | Union Iron Works | 83.6 | 88.9 |
| K-8 | .... | .... | Union Iron Works | 83.0 | 88.4 |
| L-1 | .... | .... | Fore River Shipbuilding Co. | 22.8 | 30.3 |
| L-2 | .... | .... | Fore River Shipbuilding Co. | 22.5 | 30.3 |
| L-3 | .... | .... | Fore River Shipbuilding Co. | 22.5 | 30.3 |
| L-4 | .... | .... | Fore River Shipbuilding Co. | 22.4 | 30.2 |
| L-5 | .... | .... | Lake T. B. Co | 7.4 | 8.1 |
| M-1 | .... | .... | Fore River Shipbuilding Co. | 14.1 | 20.8 |
| L-9 | .... | .... | Fore River Shipbuilding Co. | 0.0 | 1.9 |
| L-10 | .... | .... | Fore River Shipbuilding Co. | 0.0 | 1.9 |

COLLIERS

| | | | | | |
|---|---|---|---|---|---|
| Kanawha | 14,000 | 14 | Navy Yard, Mare Island | 31.5 | 49.0 |
| Maumee | 14,000 | 14 | Navy Yard, Mare Island | 17.5 | 25.9 |

TRIALS OF THE UNITED STATES DESTROYER MCDOUGAL.—On her official trials, held early in May, the United States torpedo boat destroyer *McDougal*, built by the Bath Iron Works, Bath, Me., averaged for five full-speed runs over the Rockland measured mile a speed of 31.516 knots. The highest speed obtained was 32.07 knots.

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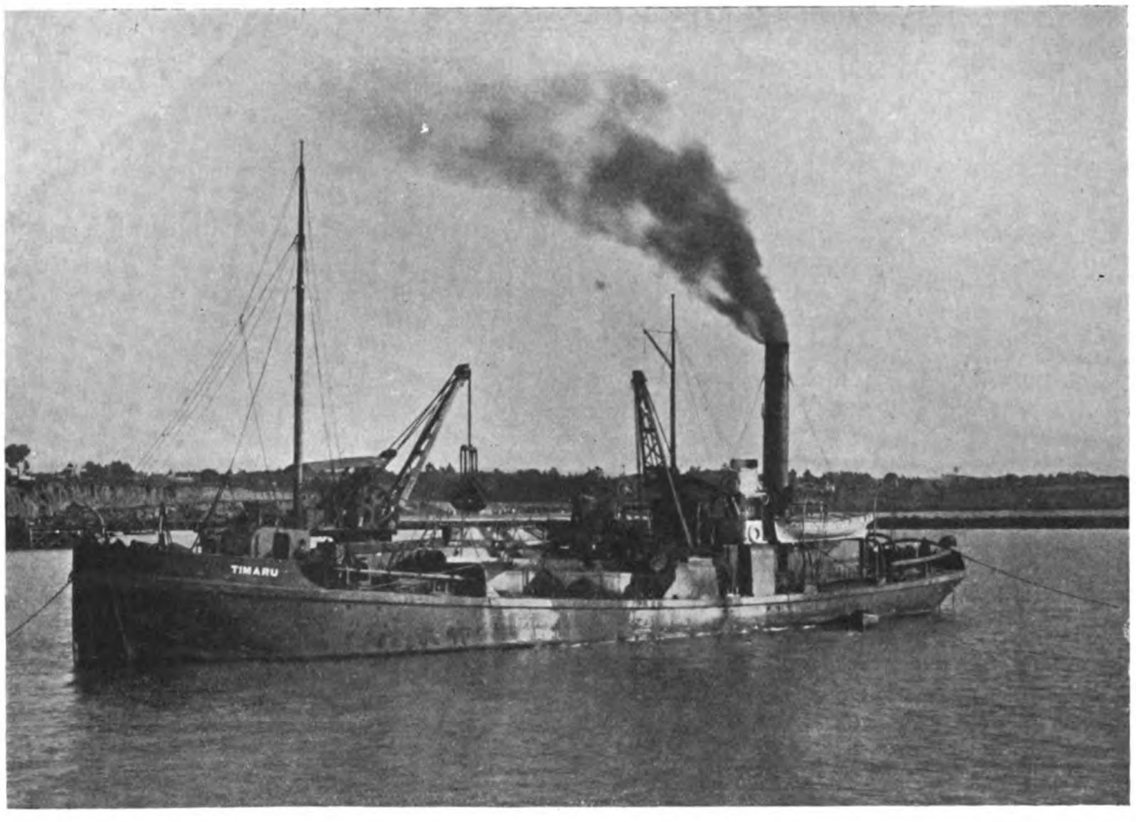
## ENGINEERING SPECIALTIES

### Kingston Dredger and Excavator

Messrs. Rose, Downs & Thompson, Ltd., of Hull and London, E. C., design and manufacture self-propelled steam hopper barges equipped with two or four Kingston dredges fixed fore and aft of the hopper well. The illustration shows a 500-ton hopper barge with two fixed dredgers and separate propelling engines and a marine boiler. Dredgers of this description can be supplied capable of a total output of from 2,000 to 5,000 tons. The principal advantages of this type of dredger over the more costly ladder dredgers are general handiness, ability to dredge among shipping and along door walls, and the low cost of repairs and operation. With this type of dredger stopping for repairs is avoided, as in the event of one machine giving out the others can continue working. Steam is supplied direct from the marine boiler to the Kingston dredging machines fixed fore and aft of the hopper.




### Results from Service Tests of Eckliff Boiler Circulators and Purifiers

Trouble from scale formation led to the recent installation of seventeen circulators and purifiers manufactured by the Eckliff Automatic Boiler Circulator Company, Detroit, Mich., in a number of Scotch and fire-box boilers on dredges and tugs owned by the Great Lakes Dredge & Dock Company of Chicago. Before the installation of these circulators the heating surfaces of the boilers were coated with a heavy accumulation of scale, which greatly impaired the efficiency and economy of the boilers. After the circulators were installed the scale gradually peeled off until the heating surfaces were practically clean and, by the operation of one blow-off valve on each boiler for a period of 30 seconds every 6 hours, it was found that no further scale formed on the heating surfaces and that the boilers could be operated indefinitely without washing. In addition to the above results the consumption of fuel was reduced to a remarkable extent, in some cases as much as 15 percent.

The first installation was made on September 14, 1913, in a three-furnace Scotch boiler 11 feet 6 inches diameter by 13 feet long, on the tug *J. McCarty,* which was operated in the Chicago drainage canal and vicinity towing scows and dredges. Previous to the installation of the circulator and purifier on this tug so much mud accumulated in the bottom of the boiler in one week's operation that it was necessary to wash the boiler once every seven days, and the fuel consumption covering a period of 30 days was 1,360 pounds per hour. At the end of 30 days' operation, after installing the circulators and purifiers, it was found necessary to open the boiler and remove the accumulation of hard scale that had peeled off the furnaces and tubes. The boiler was then closed and operated continuously for six weeks before a sufficient quantity of hard scale had again accumulated to interfere with the automatic removal of the soft residue in the bottom of the boiler. At that time a thorough examination of the tubes and furnaces was made and they were found to be almost entirely free of any scale formation.

During the first 30 days following the installation of the circulators and purifiers the average fuel consumption was only 1,240 pounds per hour, or 9 percent less than before the circulators and purifiers were installed. As the balance of the scale continued to peel from the heating surfaces, the fuel consumption was further reduced so that the last records available show a reduction of 15 percent.

The Eckliff system of circulators and purifiers is totally independent of all feed pipes and any other connections on the boiler. The results obtained were accomplished without the use of any chemical or mechanical means, and the removal of the scale from the tubes and furnaces was brought about solely by the conditions created inside the boiler by the circulators. Scale formation on the heating surfaces of a boiler equipped with Eckliff circulators and purifiers, it is claimed, is positively prevented because the feed water is purified in-

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side of the boiler below the level of the grates, and all of the solid residue contained in the feed water is precipitated to the bottom of the boiler away from any heating surfaces, where it remains in the form of soft sludge until automatically blown out of the boiler.

In the case of the tug *J. McCarty*, the feed water was taken directly from overboard and delivered to the boiler without having passed through any exterior feed water purifiers and was heated only in an exhaust heater to a temperature not exceeding 190 deg. F. Immediately following the installation of the circulators and purifiers this boiler was filled with water at a temperature of 70 deg., and within 45 minutes after the fires were lighted in the three furnaces the steam gage indicated 120 pounds pressure. The thermometer, which was attached to the boiler so that the mercury bulb was between the bottom of the combustion chamber and the boiler shell, and completely surrounded by the water contained in the boiler, indicated a temperature at the extreme bottom of the boiler of 337 deg. F. Fifteen minutes later the steam gage indicated a pressure of 165 pounds and the temperature of the boiler under the combustion chamber was 368 deg. F. Considering the fact that the ordinary Scotch boiler must be fired very gradually from 12 to 24 hours before steam is allowed to generate, this test indicates the rapidity and positiveness of the circulation induced in a boiler equipped with the Eckliff system of circulators. Owing to the fact that the temperature of the contained water is equalized at all times throughout the boiler, this rapid firing can be done without injury to the boiler, as the strains due to unequal expansion and contraction are entirely eliminated. It is also found that through the equalization of temperatures throughout the boiler pitting, grooving, corrosion, breaking of staybolts and the formation of furnace cracks are prevented, while the girth seams of the boiler remain dry and tight.

As the result of the test in the tug *J. McCarty* the Eckliff system of circulators and purifiers has been installed in one fire-box and thirteen Scotch boilers on other dredges and tug boats owned by the Great Lakes Dredge & Dock Company.

### A Large Order for Dredger Pins

Messrs. Edgar Allen & Company, Ltd., Imperial Steel Works, Sheffield, have filled an order from the Argentine Government for 43 tons of dredger pins to be made from Allen's Imperial manganese steel. The characteristics of this steel, such as its extreme toughness, combined with hardness, make it a particularly suitable material for dredger pins, and also for other wearing parts of dredgers, such as bucket lips, corner pieces, bushes, elevator chain links and many other parts of crushing and grinding machinery.

## Personal

JOSEPH W. POWELL, formerly assistant to the president of Wm. Cramp & Son's Ship and Engine Building Company, Philadelphia, Pa., has succeeded Rear Admiral Francis T. Bowles as president of the Fore River Shipbuilding Corporation, Quincy, Mass.

D. E. FORD, for twenty years naval architect and superintending engineer of the Standard Oil Company, New York, has opened an office as consulting engineer, naval architect and ship and engine surveyor and appraiser in San Francisco, Cal.

CLARENCE BAILEY, of Albany, N. Y., has been appointed chief engineer of the Hudson River Day Line steamer *Albany* on the retirement of Cornelius Midlam, who was probably the oldest active engineer on the Hudson River. Edward Van Heusen, of New Baltimore, N. Y., will be Mr. Bailey's first assistant engineer.

FRANK W. SEAMAN has been promoted from first assistant engineer to chief engineer of the steamer *Berkshire* of the Hudson Navigation Company, succeeding Thomas D. Borne, chief engineer of the *Adirondack*, who has been acting chief engineer of the *Berkshire* since the death of the former chief engineer, David Allardice.

P. J. KILLION, formerly with the Albany Towing Company, has been appointed chief engineer of the tug *Colonel Stair*. This tug was formerly named the *George D. Cooley*, but was renamed when bought recently by the United States Government for the upper Hudson River improvement. The tug will be commanded by Captain James Allen, formerly with the Newburgh Dredging Company.

HENRY STAMMELL, formerly of the Albany Towing Company, has been appointed chief engineer of the passenger steamer *Hudson Taylor*, commanded by Captain Edward McCabe. The *Hudson Taylor* has been placed on the route between Albany and Troy, N. Y., by the Central Hudson Line, carrying the freight formerly handled by the larger boats which went to Troy in the evening.

BURTON COLVIN has been appointed chief engineer of the *Augustus Phillips*. This vessel, which formerly ran on the Albany and New Baltimore route, has been taken over by new owners, and will hereafter be operated on the longer route between Coxsackie and Albany, N. Y., stopping at way landings. Captain Charles Hovey, of Schodack, N. Y., will have command of the vessel.

EDWIN FITZGERALD has been appointed chief engineer of the steamer *St. Johns*, owned by the Potomac & Chesapeake Steamboat Company, Washington, D. C. This boat will make her first trip to Colonial Beach May 30. Captain Chapman Sly is in command of the vessel.

A. L. GEEN has been appointed chief engineer of the steamer *Frederick Du Barry*, recently purchased by the Potomac & Chesapeake Steamboat Company from a steamboat company on the St. Johns River, Florida. This boat will be placed on the Colonial Beach route on the Potomac River as soon as repairs, made necessary by the stormy passage up the Southern coast from St. Johns River to Washington, are completed. The vessel will be commanded by Captain W. L. Davis.

F. P. O'DONNELLE has been appointed chief engineer and Captain George Windsor commander of the steamer *Charles Maccalister*, of the Mt. Vernon & Marshall Hall Line, Washington, D. C.

H. F. JOHNSON, first lieutenant of engineers, who is now chief engineer on the revenue cutter *Apache*, which arrived in Washington, D. C., from Baltimore, Md., on May 16, and is again on a cruise in Chesapeake Bay, will soon be detached and ordered to service on the revenue cutter *Gresham* on the Boston station. Second Lieutenant of Engineers E. S. Adison, who has been on duty on the revenue cutter *Guthrie*, will take Lieutenant Johnson's place in charge of the engines of the *Apache*.

## Obituary

ALEXANDER B. SCULLY, president of the Scully Steel & Iron Company, Chicago, Ill., died suddenly at his home in Chicago May 7, aged 58.

WILSON B. CHISHOLM, president of the Champion Rivet Company, Cleveland, Ohio, died May 10 after a protracted illness, aged 65.

JAMES SHEWAN, Sr., head of the dry dock firm of James Shewan & Sons, Brooklyn, N. Y., died at his home in New York May 7 at the age of 66.

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# SELECTED MARINE PATENTS

*The publication in this column of a patent specification does not necessarily imply editorial commendation.*

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millertown, N. Y.

1,088,079. ENGINE GOVERNOR. FRANK M. LEAVITT, OF SMITHTOWN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

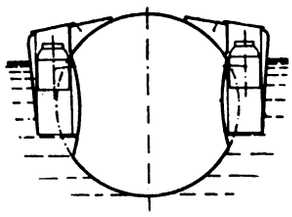
*Claim* 1.—In an automobile torpedo a governor comprising a driving part, a rotor driven therefrom, interposed gearing, including a member movable with variations in the resistance offered by said rotor, and speed-controlling means operated by the movements of said movable member. Twelve claims.

1,089,338. LIFE-RAFT. ERNEST R. GREENE, OF HANOVER, N. H.

*Claim* 1.—In a life-raft, a framework, a buoyant member carried by said framework, a continuous, flexibly mounted piece of waterproof material secured to said framework, and a waterproof body portion or hull secured to said piece on a line between its top and bottom. Seventeen claims.

1,089,543. SUBMARINE BOAT. FERNAND FENAUX, OF LE HAVRE, FRANCE, ASSIGNOR TO CHANTIERS ET ATELIERS AUGUSTIN NORMAND, OF LE HAVRE, FRANCE, A CORPORATION OF FRANCE.

*Claim* 1.—A submarine boat provided with a series of mine retaining cells, said cells provided with upper and lower openings to permit the



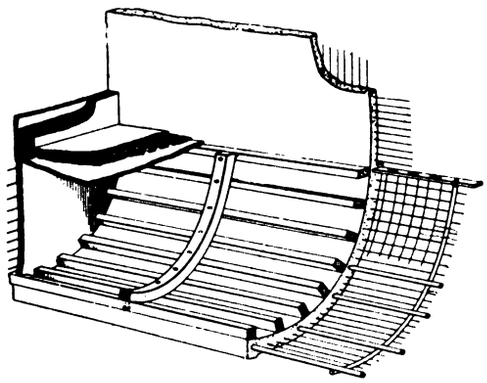
mine to be moored in an upward or downward direction. Three claims.

1,089,405. REINFORCED CONCRETE DOCK OR PIER. WILLIAM S. FERGUSON, OF CLEVELAND, OHIO, ASSIGNOR TO J. D. CAREY, OF CLEVELAND, OHIO.

*Claim* 1.—In a concrete dock, a foundation of upright piles, metallic rods crossing the upper ends of said piles, a second set of metallic rods at right angles to said first-named rods, a concrete structure formed upon said rods and incorporated therewith, said structure comprising a front wall and a base, bracing walls connecting said front wall and base adapted to support the compression strain, and means inserted in said bracing wall for supporting the tensile strain. Sixteen claims.

1,090,349. BOAT CONSTRUCTION. HARVEY ELVIN SMITH, OF REPRESA, CAL., ASSIGNOR OF ONE-HALF TO ROBERT C. JOHNSON, OF REPRESA, CAL.

*Claim.*—A device, including a concrete hull having a keel, lengthwise running reinforcing rods having eyes embedded in said hull, embedded transverse U-shaped strut rods passing through said eyes, oppositely positioned apertured bars embedded within said hull, the ends



of said strut rods being secured within apertures of said bars, lengthwise running reinforcing wires embedded within said hull below said strut rods, and a plurality of strut wires threaded through the apertures of said bars and intertwined between said reinforcing wires. One claim.

1,090,271. PROPELLER. CHESTER A. BRYAN, OF HALL CITY, FLA.

*Claim* 2.—In combination, a propeller hub having oppositely arranged dove-tailed recesses which are tapered longitudinally, propeller blades having bases shaped correspondingly with regard to the recesses and fitted therein, the bases having teeth, spring members secured in the recesses having lateral portions to engage the teeth to prevent longitudinal displacement of the bases in one direction, while the longitudinal taper of the recess prevents displacement of the bases in an opposite direction, and means for disengaging the lateral portions of the spring members from the teeth. Two claims.

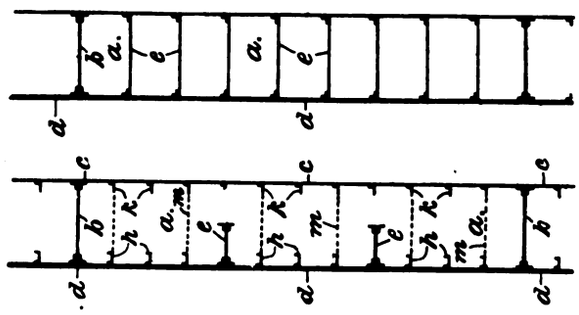
British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

25487/1912. INDICATING THE SPEED OF A VESSEL IRRESPECTIVE OF A TIDE OR CURRENT. A. G. NOBLE, F. R. G. S., OF 11 BRUNSWICK STREET, LIVERPOOL.

*Claim.*—Relates to means for quickly ascertaining the speed of a vessel, or the strength of a current in which it is floating, consisting in two fixed sighting devices, arranged parallel to each other at a considerable distance apart on the vessel, and one stationary point some distance off (or two stationary points in a line nearly parallel with the direction of the vessel, an a single fixed sight on the vessel). An electric or other chronograph and electric contacts are arranged at each sighting position for instantaneously placing a record on the chronograph the instant a sight is taken. The speed is taken afterwards at leisure by means of tables provided.

26,269/1912. IMPROVEMENTS IN SHIPS' CONSTRUCTION. T. T. JONES, OF PIERHEAD, LIVERPOOL, LANCASTER.

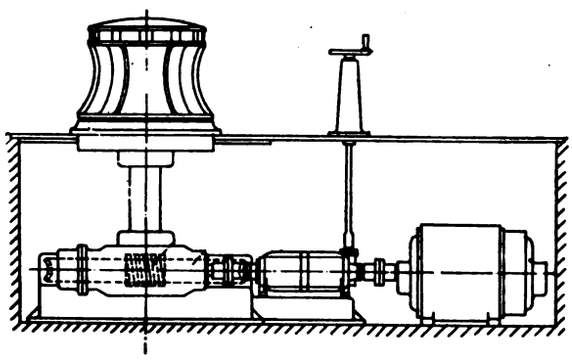
This invention consists of a modification of the metal ships' construction of Patent No. 10,405 of 1912. At the sides of the true shell of the ship is disposed within the frames and outer shell, and at or along the bottom it is on the outside of the ship; while the inner skin at the



latter part constitutes the bottom tank tops. Between vertical imperforate web-frames, as *b*, spaced at long intervals, and forming vertical watertight diaphragms between the shell plates *d* and *c*, and making the spaces between these diaphragms watertight compartments, intervening frames *e* of relatively light and of non-watertight construction, are employed, and extend from the inner shell to the outer (to which they are connected). Some of the frames, *h*, which lie midway between the web frames *e* and a diaphragm *b*, and between the web frames *c*, are, at their upper parts, connected to the frames *k* by a partition or web plate extending between them.

26376/1912. IMPROVEMENTS IN POWER-DRIVEN CAPSTANS. THE VARIABLE SPEED GEAR, LTD., AND J. ROBSON, OF BROADWAY COURT, WESTMINSTER, LONDON.

According to this invention the capstan head is actuated by a motor which is worked from a pump capable of supplying liquid to the motor at varying rates of flow, the pump and motor being preferably consti-



tuted by the pump and motor units of a variable transmission gear, which may comprise a cylinder barrel having a number of parallel cylinders for the reception of pistons provided with piston rods that are pivotally connected to the pistons and to a plate carried by a tilting box which, in the case of the pump unit, is displaceable so that the plate can be adjusted to any desired inclination with respect to the barrel in order that the direction and rate of flow of the liquid can be caried at will.

900/1913. IMPROVEMENTS IN SHIPS' BULKHEADS. T. R. OSWALD, OF "RIVERVIEW," BEACONSFIELD ROAD, BLACKHEATH, LONDON, S. E.

*Claim.*—The bulkheads according to this invention are reinforced by stringers attached to them and to the sides of the vessel, such stringers being widened at their ends for the purpose (and also for strengthening the sides of the vessel). The bulkheads may be further strengthened by one or more buttresses of hollow formation and are arranged on one or both sides of the bulkhead, being efficiently attached to the bulkhead as also at the head to the deck and at the foot to the tank-top on one or both sides of the bulkhead, being efficiently attached to the pumps or as passages or for ladders, etc.

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